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FREIGHT TERMINALS AND TRAINS

INCLUDING A REVISION OF YARDS AND TERMINALS

BY

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McGRAW-HILL BOOK COMPANY
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PREFACE

The favorable reception accorded "Yards and Terminals," published by the Railway Age Gazette in 1906, and the many requests for a revised edition, encouraged the writer to undertake this revision. The results have been practically a new book. The scope has been greatly enlarged and the treatment broadened, so that the new material exceeds by a considerable amount the revised portions of the former book. Hence it seemed both wise and necessary to give the book a new title.

The volume is essentially a treatise on freight transportation in all its ramifications. The subject is treated from the viewpoint of the engineers who plan, build and maintain, and the officers who operate the various plants which are cogs in the great machine. The importance of the freight station, where the freight is received or delivered and cared for prior or subsequent to road movement, as well as the responsibilities and methods of the agent are recognized. The viewpoint of the yardmaster and his subordinates is developed at length; as is that of the trainmaster and train forces, on whom devolve the safe, expeditious and economical movement of trains. The mechanical department is considered, and the important relation which the engine terminal and its operation bear to train and yard service is discussed in detail. The attitude and problems of the management, responsible for favorable net returns, are constantly kept in mind.

It may seem that the volume is made unnecessarily large by the many detailed descriptions of yards, terminals and equipment. Because of the expressions of many readers of the former volume on the value of such details, it was deemed unwise to curtail them. No two terminals are alike in their physical and traffic characteristics. Every illustration of successful design or description of good operating methods is consequently of assistance to the railroad man who is seeking new ideas to help solve his own problems.

It has been the writer's aim to present fairly all shades of opinion on questions of design and operation and, to that end, he has quoted freely from the opinions of recognized experts. In most instances acknowledgment is made in the text where these quotations appear. The writer wishes further to express his grateful appreciation to the Railway Age Gazette, the Engineering News, the Railway and Engineering Review, and other railroad and technical periodicals, and to the many railroad officers and others for valuable information and assistance. Frequent quotations have been made from the committee reports and

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codes of the American Railway Association, the American Railway Engineering Association, and the Master Mechanics' Association.

For constructive criticism the writer is indebted to Charles B. Breed, Associate Professor of Civil Engineering, Massachusetts Institute of Technology, and William J. Cunningham, Assistant Professor of Transportation, Harvard University. In addition to helpful suggestions on other parts of the book, Professor Breed wrote Chapter IV—"Track and Maintenance Details"—and Professor Cunningham, Chapter XXI on "British Freight Service."

PROVIDENCE, R. I.,
July, 1912.

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FREIGHT TERMINALS AND TRAINS

CHAPTER I

THE TERMINAL PROBLEM

On June 30, 1911, there were in the United States 243,299 miles of single track, 23,454 of second track, 2429 of third track, 1677 of fourth track and 87,524 of yard and side tracks; a total of 358,383 track-miles. For every 3 miles of railroad there is in use to-day 1 mile of switching or terminal tracks. A glance at these figures indicates clearly that the terminal feature of railway operations is very important. It has been computed that the switching mileage of some of the larger roads reaches as high as 35 and 40 per cent. of the entire number of revenue train miles. With the general increase in business handled, and density of traffic, and the more insistent demands of the public for quicker movement and delivery, the difficulties of the problem will increase rather than decrease. The importance of terminals and terminal operation, therefore, justify the most careful and comprehensive study.

The following statistics based on figures in the 1910 annual report of the Interstate Commerce Commission (the latest complete report available at this writing) are surprising to one who has not studied the results, indicating as they do, (1) that only 55 per cent. of the capacity of freight cars is utilized; and (2) that the average miles each freight car is moved per day is ridiculously low.

On June 30, 1910, the railroads of the United States owned 2,133,531 freight cars having an average capacity of 36 tons each. These cars carried 1,849,900,101 tons of revenue freight an average distance of 138 miles. Altogether the cars made 18,355,815,771 miles in revenue service, of which 12,857,357,254 or 70 per cent. were loaded, and the total revenue ton-miles amounted to 255,016,910,451. Dividing the total revenue ton-miles by the total revenue loaded freight car-miles, it will be seen that the average load per car was but 19.8 tons or only 55 per cent. of the average car capacity.

According to the 1910 statistics, the mileage of yard tracks and sidings in the United States represented 24.4 per cent. of the whole, while in group 1 (the New England states), it was 28.8 per cent.; in group 2 (New York, New Jersey, Pennsylvania, Delaware, Maryland and District of Columbia), 32 per cent.; in the western country, group 9

(Louisiana and part of Texas and New Mexico) and group 7 (Nebraska, Montana, Wyoming, No. Dakota, So. Dakota and part of Colorado) it was 18.1 and 19.7, respectively. In 20 years, 1890 to 1910, it increased from 21.6 per cent., in group 1, to 28.8 per cent.; in group 2, from 24.4 to 32.5; group 7, from 12.9 to 19.7; group 9, from 10.5 to 18.1, and in the United States, as a whole, from 16.8 to 24.3 per cent. These figures clearly show the increasing importance of the terminal problem with relation to road movements. That the relative increase of the percentage of yard tracks and sidings in the United States was 44.6, per cent. running up to 52.8 and 72.4 in groups 7 and 9, respectively, and only 28.7 and 33.4 in groups 1 and 2, respectively, tells a story of shortsightedness years ago, in not providing for necessary expansion where it was most needed and before industrial development and increased property values rendered it almost prohibitive.

It is not possible to ascertain the average daily mileage of serviceable cars from the Interstate Commerce figures because they do not take account of cars out of service for repairs, or cars stored in periods of depression. On an average about 7 per cent. of a railroad's freight cars are in the repair shops. The percentage out of service because of a surplus of equipment varies within wide limits. But taking an average month, it is shown by the monthly statistics of the American Railway Association's Committee on Relations between Railroads, that in May, 1911, freight car performance was as follows:

Mileage of 144 roads reporting,	223,680
Revenue freight cars owned,	2,174,628
Per cent. of cars in shop,	7.83
Freight car mileage,	1,626,664,629
Average miles per car per day,	23.7
Per cent. of loaded car mileage,	67.4
Average ton-miles (revenue and non-revenue) per car-mile (loaded and empty),	14.2
Average ton miles (revenue and non-revenue) per loaded car-mile,	21.2
Average ton miles (revenue and non-revenue) per car per day,	338

Since the average speed of a freight train from terminal to terminal, including road delay, is from 10 to 15 miles per hour, it is plain that 2 to 3 hours in a train will give a freight car the average mileage per day shown by the above statistics. This indicates that freight cars are in motion just about 10 per cent. of the time, and since but 55 per cent. of their capacity is utilized, when loaded, irrespective of empty car movement, a clear indication is given of the need for railroads to pay particular attention to methods and facilities which will on one hand increase the percentage of car capacity utilized and on the other hand reduce the delay to freight cars in loading, unloading, and movement through yards and terminals.

The average gross freight revenue per ton-mile on all the railroads of the country in 1911 was 0.754 cents; in round figures about three-quarters of a cent. The cost of terminal handling is approximately 25 cents per car handled, which includes switching in two yards. This estimate is based on an average load of 10,000 to 12,000 lb. of merchandise freight. About 25 cents per ton more should be added for handling at the outbound freight-house and a like amount at the freight-house of final

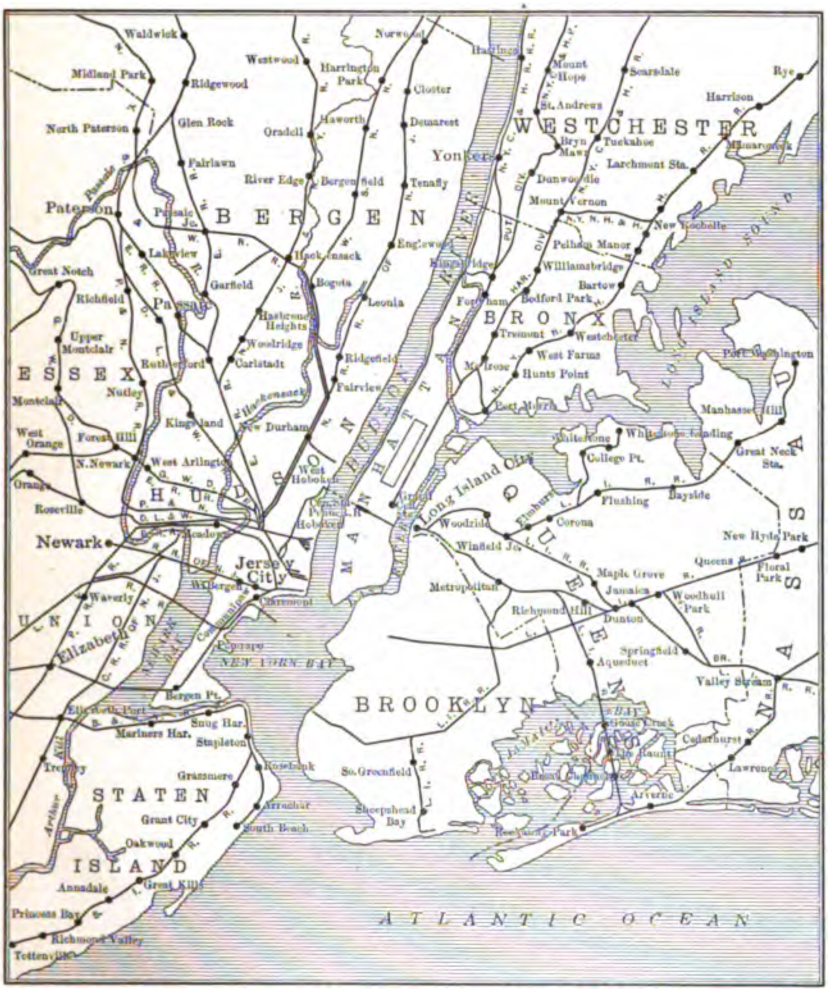

FIG. 1.—Map of New York and tributary railroad frontage.

destination. Added to these charges is a similar cost at each of the transfers through which a shipment may move. This handling cost aggregates a total of 70 to 90 cents a ton, without accomplishing any actual movement toward destination, an equivalent to the average gross revenue obtained for a 65- or 70-mile haul.

There are but two roads actually entering New York City to-day as freight carriers, although sixteen make it a terminal. The fourteen others find it necessary to use water transportation to deliver freight to and move it from the city. There are, nevertheless, nearly one hundred transportation companies (rail and water) having freight stations in New York City. Some of these companies have as many as six or seven different stations. Fig. 1 is a map of New York City and its harbor, showing railroads entering it and their yards and terminals. A recent casual visit showed thirty-five loaded trucks in line in front of one dock on West Street, New York, and this is not uncommon. It costs $7 a day, including driver, to maintain a two-horse truck in New York City. It is claimed that hundreds of these trucks are kept waiting in line, in this city, from 2 to 6 hours a day during seasons of heavy traffic movement. The loss due to congested and inadequate terminals from this item alone is enormous.

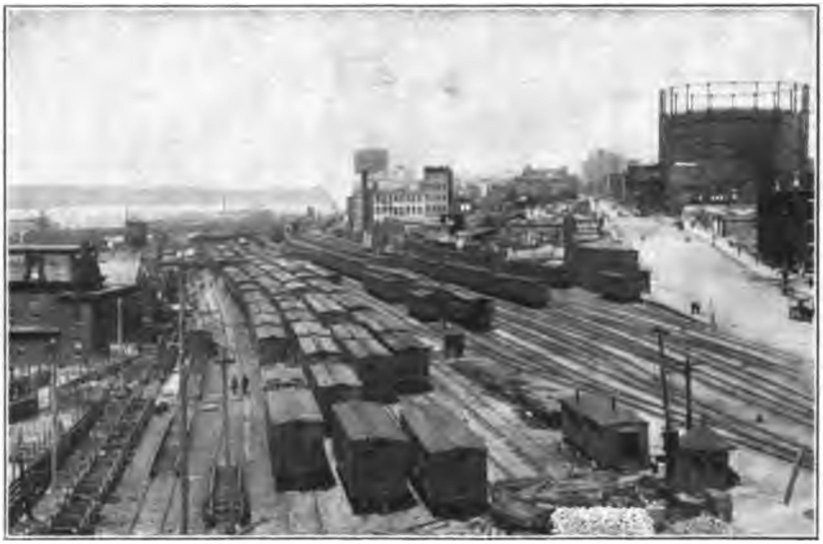

Fig. 2.—The only freight yard in New York—East 69th Street.

Handling freight traffic in and through New York is doubtless the most complicated terminal problem in the world and from it alone many lessons may be learned. New York being the greatest port of entrance to this country, the increasing volume of traffic together with the growing demands for quicker movement would in themselves present endless operating and traffic problems. But added to this is the constant tendency on the part of industries and warehouses to crowd the water's edge to an extent which either necessitates the confinement of railroad lines to their present limits or compels enormous expenditures to secure more territory, as has recently been done by the Pennsylvania railroad. The foreign commerce of the port of New York is very nearly one-half that of the entire United States. The view shown in Fig. 2 is characteristic of the railroads' rapidly vanishing foothold in New York City.

Handling New York's freight traffic requires an enormous water fleet to care for the lighterage, and an extensive system of water-front piers, docks and float bridges for the transfer of freight between the rail and water lines, in addition to the large freight yards for classifying, delivering and forwarding freight cars. There are no exact records of the number of boats engaged in the New York harbor lighterage business, but the figures at hand indicate that there are about 10,000 craft engaged in this work in New York harbor. About 1000 of these are steam vessels and the remainder are without power. Within the harbor limits there are about 50 dry docks and plants for marine construction and repairing, representing investments aggregating about $10,000,000. To show what has been done and what may be expected in the way of future development the following figures of the length of available wharf berths along the New York harbor water front are given.

	Water-front miles		Length of wharves
Manhattan,	44		93
Brooklyn,	132		197
Queens,	116		132
Richmond,	51		69
Bronx,	105		113
Total,	448	Total,	604
N. J. Shore—Amboy to Fort Lee,	30		96
Total,	478	Total,	700

The Department of Docks and Ferries collects from leases and wharfage more than $5,500,000 annually. In addition to the thousands of tons of freight handled by lighters there are about 1000 cars handled on floats daily between Canal Street on the North river and Jackson Street on the East river. The usual charge for lighterage, as prorated, is 3 cents per 100 lb., and the claim is made that in some instances the actual cost runs as high as 3.75 or 4 cents.

The railroads bring about 13,000,000 tons of freight into New York annually, of which nearly 11,000,000 tons require drayage and over

2,000,000 tons are lightered. About 4,500,000 tons are exported from New York annually, of which 75 per cent. requires drayage and the remainder lightering. Fig. 3 is a typical New York water scene looking northward up West Street along the North river.

It is safe to predict that in time freight will be moved continuously into and through New York through river tunnels. Passenger tunnels are in operation and have demonstrated the feasibility of similarly handling freight. Large, or larger, classification yards will be built on the Hackensack meadows, in New Jersey, a few miles from the Hudson river. Tunnels under the narrows or upper bay will link Staten Island and New Jersey with Long Island, which, with the bridge route over the East river, now building, will complete the route to New England, eliminating the 14-mile slow and expensive float movement between the roads on the New Jersey shore and the terminii in the upper part of Manhattan with the rail lines leading into New England and the Canadian Provinces. The Baltimore & Ohio now has terminals on Staten Island; a tunnel thence to Brooklyn under the lower bay would give this road, and its allies, the Reading and Central of New Jersey, direct all-rail connection with New England.

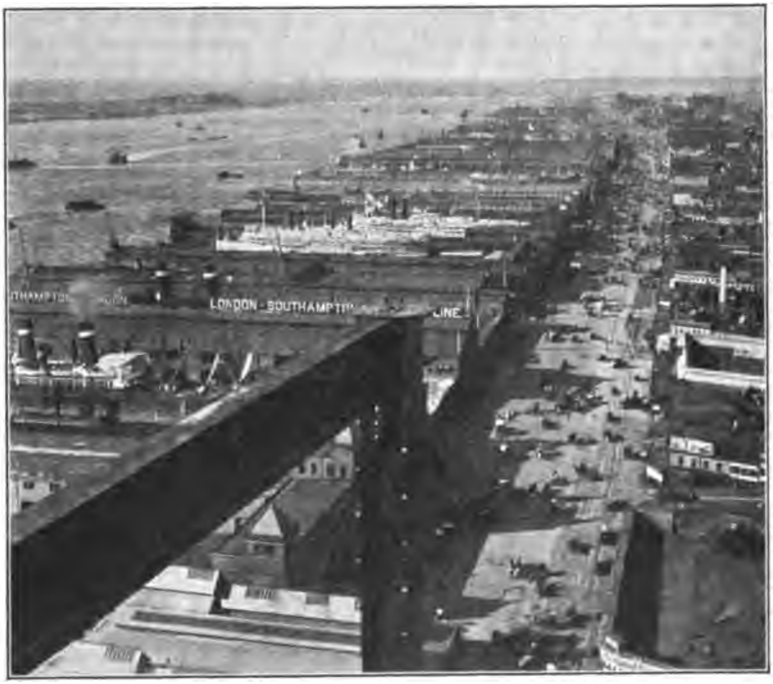

Fig. 3.—North River water front—New York.

It is only during a comparatively recent period that the southern states have supplied the northern and northwestern markets with early fruits and vegetables in any considerable quantity. It has now become a regular part of the business of some of the coastwise railroads to haul watermelons and other fruits and vegetables north during certain seasons, and, a few weeks later, to haul similar commodities in the opposite direction. Florida, Georgia and other southern states may ship melons or strawberries to Virginia, Maryland and points north, while the melon growers of Virginia later on supply the Georgia and Florida markets when the southern crops have become exhausted. This is made possible only by cheap and prompt transportation and the extent to which this condition may be developed is difficult to overestimate.

It is well stated by Wellington in his "Economic Theory of Railway Location," that in planning a railroad there are three ends to be attained:

> "1. To sell all the transportation possible.
> "2. To dispense with all the train-miles possible.
> "3. To reduce the cost of running trains per mile.
>
> "As respects freight traffic, rates must in the long run be made equal, not simply from station to station, but from the door of the consignor to the door of the consignee; in other words, all additional cost for cartage or switching service and something more as compensation for the trouble (usually a very considerable addition) must be borne by the railroad, before it is in a position to compete at all."

The terminal problems confronting railroad managers are usually those which involve the correction of errors previously made or, more accurately, the providing of facilities at an enormous cost which could have been furnished at a moderate cost had the terminals been properly designed when the roads were built. In some instances these conditions were due to lack of foresight. In many cases, however, it was the paramount desire of running a line to a large city and the failure to provide sufficient funds to carry the line well into the terminal city. Or, in the words of Wellington,

> "Had it not so often happened that roads which have expended millions for the construction of long lines to a certain place have then begrudged or failed to raise the necessary additional money to carry their line into it, contenting themselves with hanging to the skirts of the town somewhere where they can be reached by horse-cars or hacks and drays, it would seem incredible that business corporations could so frequently commit an act of folly which can fairly be paralleled with that of building a long bridge and erecting every span but one—assuming, on account of some difficulty with foundations, or what not, that a ferry would be good enough for that because it would be 'such a little one'."

There have been notable exceptions and these are the lines which are now successful in making money on freight traffic even at the prevailing low rates. As a result of this policy the railroads are now adding to, revising or remodeling existing yards and terminals, while the creation of new yards is not so common. For this reason the "ideal" or "model" yard is mainly interesting in that it affords a guide for revising extensively, remodeling or adaptating existing inadequate yards.

The relative importance of terminals and main line has been given, taking into account the cost of operating and the miles of track in use. Viewed from the standpoint of the amount of capital invested the importance of terminals is even greater. The terminals alone represent a greater amount of money than all the remainder of the properties of the roads. This statement is true even when smaller or intermediate stations are omitted and only the great water terminals and general internal distributing centers, known as division terminals or yards, are included. Their relative financial value in the countries of Europe is necessarily even greater than in the United States. In England alone hundreds of millions have been spent in remedying initial errors to enable successful transportation lines to reach the centers or interiors of great cities. Millions have been spent by the larger roads in improving their various terminal points, and apparently such additions will always have to be made.

One of two great railway systems in the far northwest, in competitive railway building, is said to have expended between $11,000,000 and $12,000,000 for terminals in a single coast city to care for an extension 180 miles long, which amounts to a charge of $64,000 per mile of line for terminals alone. Terminals for a new four-track trunk line in New York City would cost anywhere from $125,000,000 to $150,000,000. Even on the Jersey water front they would cost $75,000,000. This amounts to from $75,000 to $150,000 per mile for the tide-water terminal alone, for a line from Chicago to New York.

In Chicago, the problem is presented in a form more concentrated than in many other places. The business district comprises about one and a half square miles. It is almost completely surrounded by railway terminals, 25 trunk lines, having their freight and passenger stations ranged around this one point. Naturally with these railroad terminals depositing their enormous volume of freight in so circumscribed an area the conditions soon became unbearable. It was estimated that 112,000 tons of freight a day were handled at the terminals around the business section.

To relieve this congestion the Chicago freight subway was begun in September, 1901. Over 65 miles of subway have been completed, and this is being added to. It is the only subway in the world designed especially to relieve the freight congestion of the streets. The tunnel is egg-shaped, with concrete walls 10 in. thick and a 14-in. bottom. The height of the tubes is 7.5 ft., width 6 ft., inside measurement, and their average depth below the street level is 40 ft. The work of the construction went ahead rapidly, the ground being of a character favorable to rapid progress. The first 5 miles were built in 2 months.

Most of our larger freight terminals are examples of evolution from smaller to larger yards. Like Topsy, they "jus' growed." Additional tracks were hung on wherever there happened to be a vacant piece of land and where the least grading was required. In many cases it was necessary to get any additional track facilities that could be had and at any place available to avoid congestion or blockade on the line. In other cases it was due to lack of foresight. The bill has been paid many times over.

To reduce the number of cars in service a road must handle them promptly. They must be moved over the line at the economical speed which has been found suited to thé characteristics of each part of a line. The penalty for detentions can now be figured down to a penny. It does not require much detention, due to congestion in terminals, or awkward or reverse movements, to run into large amounts in a month.

One railroad company took records on three separate occasions and found that from 81 to 84 per cent. of all the cars on the road, at the time the records were taken, were not in motion. In the ordinary course of business, cars in good order stand in yards from 3 to 10 hours. This is about the time needed to haul them to the next division terminal. In busy periods, then, it would seem that cars in good order should be kept in motion about half the time; but they are not and there is a field for an immense profit by working to approximate this ideal condition. For example, in a terimnal handling 4000 cars per day, an hour's reduction in standing, effected either by improvement in design or operation, makes a daily saving of the time of 166 cars, which at the present per diem rates amounts to $50 or $55 per day. An expenditure of nearly $400,000 to overcome this, would be justified.

The detrimental effect of the yard aptly described as one where "all tracks lead into it, none run out of it," may readily be imagined and the loss it occasions the operating road estimated. In a meeting of the Association of Transportation and Car Accounting Officers, one of the largest roads in the country testified that the average time of all freight cars in terminals on its line had been 18 hours. This it succeeded in reducing to 13 and hoped eventually to get down to 5. The 5 hours' reduction effected was remarkable and remunerative. It does not require an exceptionally large yard, in these days of heavy freight movement, to handle an average of 1000 cars per day. The 5 hours per day saved would represent 5000 car-hours, equivalent to 213 additional cars in service which, valued at $1000 each, are worth to the railroad company $213,000. To figure on the earning capacity of these 213 cars the railroad would secure an additional revenue, during times of brisk traffic, of $400 to

$500 per day. To attain this end in half a dozen main and divisional terminii would justify the expenditure of considerable thought and money. Anywhere from 60 to 85 per cent. of the freight cars on a line, at a given time, are not in motion.

As already stated, a modern box car, with its airbrake and other equipment, costs about $1000. The annual cost of maintenance, barring accidents, is somewhere between $65 and $90. A cheaply constructed warehouse will provide the same volume of storage space as a box car at a cost of less than $250, and its maintenance cost is about one-fifth that of the box car. There are shippers, nevertheless, who deem it a great injustice not to be permitted to use freight equipment freely for storage or warehouse purposes.

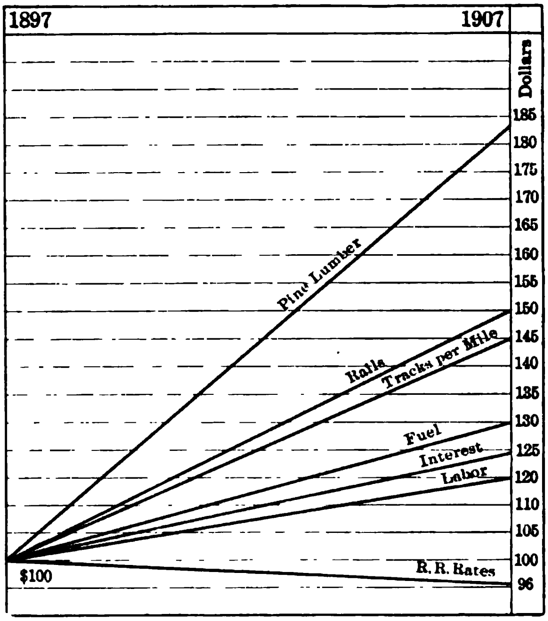

FIG. 4.—Ten years' increases in material and labor costs.

The difficulties under which our railways work to meet the increasing cost of labor and of all material required in their construction, maintenance and operation, while freight rates do not increase but in many instances decrease, is graphically shown in Fig. 4 by one large road, comparing the years 1897 and 1907.

The necessity for revising terminal facilities is made impressive by a study of those instances which increase the cost of a railway's living, as the terminals usually present the greatest opportunities for operating economies; not only in themselves but in their considerable effect in reducing the cost per train-mile on the road by furnishing easier movement into and out of yards and better train classifications.

The broad-minded, liberal and competent engineer of to-day gets all the information to be had from practical operating men before he plans his yard and avoids making many of the blunders of the past which so seriously impede operation. It is not necessary to go a thousand miles from anywhere to find track scales erected by an engineer in the middle of a 50-car double-end connected track. The yard was one of the most awkward and extravagant to operate; the yardmaster asked for scales because he needed them—and he got them. This is merely typical of the many errors made because of a lack of co-operation. There is an improvement in co-operation between engineering and operating men to-day. An engineer is not permitted to arrange for the construction of a manufacturing plant or a steamship until he has the views of the men who are required to operate it afterward; neither should he construct a terminal or yard, the operating cost of which is usually dependent on proper design and in which errors are more difficult and costly to correct. A designer—be he the designer of a house, a yacht, a machine or a yard—needs all the practical knowledge and light to be had on the subject. "Sunlight kills germs."

Stopping, starting and detaining freight trains is extremely costly, and much of this waste is due to inadequate and inefficient terminals. The cost of stopping freight trains seems to have been given little study and is not fully understood. Many trainmasters, most train dispatchers, nearly all maintenance-of-way men and yardmen seem to labor under the impression that shutting off the engine throttle and again opening it is about all there is to the performance. In some cases they make an allowance for a few minutes of lost time. Exact figures covering the cost of stopping a freight train are not to be had. It depends on the characteristics of road, grades, weight of train, and other operating conditions. There is perhaps no data of a more reliable or satisfactory nature than that given by Wellington in his "Theory of Railway Location" where he discusses the objections to grade crossings from all standpoints, including that of the necessary stops to trains:

> "Nevertheless from an economical point of view, abolishing the stops at grade crossings is by far the most important, especially when, as is so frequently the case, they reduce the number of cars hauled below what it otherwise would be. To reach this conclusion we need not adopt any of the wild estimates which give the cost of a stop anywhere from a dollar up. Without going elaborately into the details of the estimate, to discuss which properly by items would take considerable space, from 30 to 60 cents may fairly be taken as the cost of a stop, apart from all effect on length of trains. An estimate of 40 cents per stop for average trains on lines doing considerable through business can hardly be considered excessive, and at this rate the cost per year of each train per day stopping at the crossings is 365×$0.40=$146 per year."

Mr. J. A. Peabody told the Railway Signal Association (October, 1905) that, after an exhaustive series of tests, he estimated the cost of stopping and starting a six-car passenger train from and to 45 miles per hour at 35 cents; and of a 1500-ton freight train from and to 15 miles per hour at 56 cents. On this basis he figured $8000 as the cost for interlocking an entrance to a yard from a double track with cross-over, four derails, four high signals and six dwarfs, and operating cost per year $2800, made up of interest on cost at 4 per cent., $320; depreciation at 7 per cent., $560; maintenance, $840; operation, $1440. With 17 trains a day, the annual cost for stopping ($2800) just offsets the interlocking cost per year; with 30 daily trains, a net saving yearly of $2130; 70 trains, $8695, and 100 trains, $13,625.

While operating officers may from actual observation appreciate the importance of, and the necessity for correcting yard designs or adapting them to meet increased or changed traffic conditions, it is usually desirable to place an actual money value on such changes or improvements. As this is largely guesswork and dependent on so many conditions it is more difficult to estimate approximately than would be any other line of railroad improvement or betterment work. Some comparatively slight changes in tracks, connections or switches, may be made, by which, through reduced interference, cutting out lost motion, or by more direct or fewer switching movements a yard engine may be dispensed with. Estimating the expense of such an engine with its crew, fuel, supplies, etc., at $40 per day of 12 hours, we have a saving of $14,600 per year which, capitalized at 5 per cent., represents $292,000; from which it would appear that any lesser amount could profitably be expended to attain this result.

If, by correcting errors or improving the track lay-out a saving can be effected in the time of the crews of say 5 hours a day in the aggregate (and this, in a large yard, is ordinarily looked upon as a comparatively small matter) there would be saved $3194 per year, assuming the time of the road crew to be worth 75 cents per hour and leaving out the value of the engine or the demand for it. This saving represents the interest on $63,880.

It should not be assumed that an amount for the corrections or additions may profitably be expended merely because it is known that a saving in operation may be effected representing the interest on this amount, unless it is probable that the saving will be continuous. In this character of work the greater part of the money spent is for labor and much of it for material of a nature tending to deteriorate. It is therefore impossible to recover the principal, should the earnings cease.

CHAPTER II

TERMS AND DEFINITIONS

For many years there was diversity among railroad men as to the usage and meaning of terms, and the names of certain parts of railroad equipment. The writer recalls numerous instances when he was compelled to ask conductors or yardmasters whether, in telegraphing for a "pair of trucks," one truck was wanted or two. The Master Car Builders' Association helped out mankind generally and the railroad world particularly when it caused the Car Builders' Dictionary to be prepared and published. While we still have with us a few conductors and yardmasters who will ask for "a pair" of trucks when only one is wanted, it is possible to educate them, and there is now an authority for their enlightenment.

The American Railway Engineering and Maintenance of Way Association, now the American Railway Engineering Association, in 1901 made a list of terms with accompanying definitions, relating to terminals or yards, which was recently revised. Its committee made the preliminary explanation that the word "terminal" had been taken to include all the facilities provided for terminal work on a large or small scale; while the word "yard" related only to the one set of tracks which were used for the switching or storage of cars. Following are the definitions given by that society:

Terminal.—An assemblage of facilities provided by a railway at a terminus or at intermediate points on its line for the purpose of assembling, breaking up and relaying trains.

Yard.—A system of tracks within defined limits provided for making up trains, storing cars and other purposes, over which movements not authorized by titme-able or by train order may be made, subject to prescribed signals and regulations.

Receiving Yard.—A yard for receiving trains.

Classification Yard.—A yard in which cars are classified or grouped in accordance with requirements.

Gravity Yard.—A yard in which the classification of cars is accomplished by gravity.

Poling Yard.—A yard in which the movement of cars is accomplished by the use of a pole operated by an engine on an adjacent parallel track.

Summit or Hump Yard.—A yard in which the movement of cars is accomplished by pushing them over a summit, beyond which they run by gravity.

Body Track.—Each of the parallel tracks of a yard, upon which cars are switched or stored.

Ladder Track.—A track connecting successively the body tracks of a yard.

Lead Track.—An extended track connecting either end of a yard with the main track.

Running Track.—A track reserved for movements through a yard.

Relief Track.—An extended siding long enough to allow an inferior train to continue running.

Stub Track.—A track connected with another at one end only.

Spur Track.—A stub track of indefinite length diverging from main line.

House Track.—A track alongside of (or entering) a freight-house, and used for cars receiving or delivering freight at the house.

Industrial Track.—A track serving one or more industries.

Team Track.—A track where freight is transferred direct between cars and wagons.

Special Tracks.—In a typical yard there will be several tracks devoted to special purposes, varying with local conditions. These will include caboose tracks, scale tracks, coaling tracks, ashpit tracks, bad order tracks, repair tracks, icing tracks, feed tracks, stock tracks, transfer tracks, sand tracks, depressed tracks, etc.

Rail and Water Terminal.—A terminal where freight is transferred between railway cars and boats.

Wye.—A triangular arrangement of tracks used for turning engines, cars or trains.

Transfer Slip.—A protected landing place for car floats with adjustable apron or bridge for connecting the tracks on the land with those on car float.

Incline.—An inclined track (or tracks) on a river bank at a protected landing place, with adjustable apron and cradle for connecting to the track on a car float for transfer of cars.

Lighterage Pier.—An open or covered pier at which freight is transferred directly between cars and boats.

Station Pier.—A pier having no rail connections, where freight is received and delivered by car floats.

The definitions prepared by the American Railway Association relating to main tracks and train movements also have bearing upon yard work and some of them are given below:

Train.—An engine, or more than one engine coupled, with or without cars displaying markers.

Regular Train.—A train represented on the time-table. It may consist of sections.

Section.—One of two or more trains running on the same schedule, displaying signals or for which signals are displayed.

Extra Train.—A train not represented on the time-table. It may be designated as:

Extra.—For any train, except work extra;
Work Extra.—For work train extra.

Superior Train.—A train having precedence over another train.

Train of Superior Right.—A train given precedence by train order.

Train of Superior Class.—A train given precedence by time-table.

Train of Superior Direction.[1]—A train given precedence in the direction specified in the time-table as between trains of the same class.

Time-table.—The authority for the movement of regular trains subject to the rules. It contains the classified schedules of trains with special instructions relating thereto.

Schedule.—That part of a time-table which prescribes the class, direction, number and movement for a regular train.

Main Track.—A track, extending through yards and between stations, upon which trains are operated by time-table or train order or the use of which is controlled by block signals.

Single Track.—A main track upon which trains are operated in both directions.

Double Track.—Two main tracks, upon one of which the current of traffic is in a specified direction, and upon the other in the opposite direction.

Three (or more) Tracks.—Three (or more) main tracks, upon any of which the current of traffic may be in either specified direction.

Current of Traffic.—The movement of trains on a main track, in one direction, specified by the rules.

Station.—A place designated on the time-table by name, at which a train may stop for traffic; or to enter or to leave the main track; or from which fixed signals are operated.

Siding.—A track auxiliary to the main track for meeting or passing trains, limited to the distance between two adjoining telegraph stations.

Fixed Signal.—A signal of fixed location indicating a condition affecting the movement of a train.

(*Note.*—The definition of a "fixed signal" covers such signals as slow boards, stop boards, yard limits, switch, train order, block, interlocking, semaphore, disc, ball, or other means for indicating stop, caution or proceed.)

Yard Engine.—An engine assigned to yard service and working within yard limits.

Pilot.—A person assigned to a train when the engineman or conductor, or both, are not fully acquainted with the physical characteristics, or running rules of the road, or portion of the road, over which the train is to be moved.

(The definition of "yard" as given by the American Railway Engineering Association, is taken from the definitions of the American Railway Association and is therefore not repeated.)

The American Railway Association's Codes of Car Service and Per Diem Rules, contain the following definitions:

Home Car.—A car on the road to which it belongs.

Foreign Car.—A car on a road to which it does not belong.

Private Car.—A car having other than railroad ownership.

Home.—A location where a car is in the hands of its owner.

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[1] Superiority by direction is limited to single track. Some roads, particularly in New England, discard the "right by direction" and use what is commonly termed the "positive meet." Under this arrangement trains of the same class wait at meeting-points indefinitely, unless the "meet" is changed by train order.

Home Road.—The road which owns a car, or upon which the home of a private car is located.

Home Route.—The line of intermediate roads over which a foreign car was moved from home.

Home Junction.—A junction with the home road.

Home Route Junction.—A junction on the home route.

Switching Service.—The movement of a car to be loaded or unloaded, or the movement of a car between railroads, at a charge for the service rendered within designated switching limits, the road performing the service not participating in the freight rate.

CHAPTER III

GENERAL REQUIREMENTS OF TERMINAL DESIGN

The business of a freight carrier is to move freight from one point to another for a consideration and the least and cheapest possible handling enables it, ordinarily, to do this at a profit. As rates are usually rigid or have a tendency to decrease, the only way to increase the margin of profit and in many cases create it, is to reduce the cost of transportation. One of the best, if not the very best way to accomplish this is to reduce the number of cars needed to handle the business. Under the existing method of reimbursing foreign roads at per diem rates for the use of their cars, this holds absolutely true. It was frequently possible under the former method of payment on a mileage basis to hold a number of cars on tracks without expense beyond the interest on land and tracks occupied, and doubtless this is the principal reason why so many yards were operated in an expensive and awkward manner. Tracks were built for storage purposes rather than for switching. Under present methods of per diem payments, cars standing around unnecessarily are a daily loss and a drain on the margin of profit. A reduction in the number of cars used means a reduction in the cost of handling. As already explained, this holds true whether a road uses its own or foreign cars. The desideratum is to handle the business with the fewest cars possible. All good operating methods and principles dovetail into this.

In the construction of new terminals or the revision or enlargement of those already in existence, the operation of the entire railroad should be carefully considered. It is not enough to keep close watch on the efficiency of each yard or terminal separately. It is just as important that the same attention be given to co-ordinating their work and having it fit in with other phases of operation. In many cases it may be desirable, if not essential, to go beyond the limits of the road itself and study the methods, yards and character of traffic of immediate connecting lines, also probable changes in character of traffic and methods of handling. The construction and operating departments should confer closely and freely. It is usually wise to include a representative of the traffic department also, in order to obtain his views as to the necessity now and hereafter for faster time and more prompt deliveries. The traffic department should be consulted more especially with reference to the probable future volume of business to be provided for, its character, direction and new routes to be opened up with a tendency to divert traffic from established routes to or from the lines carrying it through the terminal under consideration.

The writer has in mind a case on a trunk line where a "yard" consisting of two long tracks, with a cross-over half way, sufficed for many years to enable changing of engines, inspection, etc., to be done with reasonable promptness for a comparatively heavy business. In the course of a few years it proved entirely inadequate and had to be increased to something like ten times its orginal capacity, although the traffic of the road had not increased in anything like this proportion—certainly not to exceed 15 per cent. This was due to the fact that the road originally handled a traffic consisting of about 80 per cent. of bituminous coal, requiring little or no separating or classifying and only ordinary movement as to time. New connections and traffic arrangements, a thousand miles away, produced a condition by which the traffic percentage changed. The general merchandise freight, stock, meat, etc., which formerly was 20 per cent. of the road's traffic increased to more than 50 per cent. This required different treatment.

Of late years, the tendency is to rectify the common error of leaving the matter of design—both for new and for revising old yards—entirely to the engineering department (usually with insufficient data as to existing conditions and probable future conditions) or letting the yardmaster decide the whole question. It is now the general practice to get the fullest possible co-operation between departments.

An excellent plan was adopted by one railroad company a few years ago, when confronted with the necessity for revising some of its most important yards. The general manager appointed a committee consisting of the chief engineer, the principal assistant engineer, and the superintendents, engineers and assistant engineers of all the divisions entering the yard under consideration. The superintendent in immediate charge of the yard in question acted as chairman and the committee met once a week for 2 months to prepare plans and report. The entire committee, during the first part of the period of its existence, visited large yards on other roads. The sub-committees meanwhile prepared detailed information concerning the yard to be revised. The officers engaged in this were divided into:

(1) A sub-committee to gather all the statistics of the operation and traffic of the yard.

(2) A sub-committee to make various sketch plans to be discussed by the general committee.

(3) A sub-committee to read and abstract a number of the important articles on yard design and operation in the technical journals and books for the preceding period of 10 or 15 years. These abstracts were accompanied by sketches of yards described and in shape to be readily studied by the general committee.

After the preliminary work of obtaining statistics and preparing plans, the yardmasters and their assistants were requested to attend one or more meetings of the committee and were invited to criticise the plans. The committee also interrogated the yardmasters and men with a view to informing itself fully as to details.

The fewest possible number of division terminals should be built, consistent with reasonable length of locomotive runs and the physical characteristics of the road. The latter frequently determine the point at which engines are turned. Handling locomotives at terminals is expensive. Where from 100 to 150 engines are turned per day the cost of handling ranges from $1.10 to $2 per engine. This does not include removing ashes from pits, handling coal, sand and water, or furnishing steam heat in firing up. The cost during severe winter weather, or where boilers are washed out more than once in 2 weeks, often exceeds these figures. The cost of turning an engine on the turntable depends on the power used to move the table. With hand power it is from 4 to 8 cents per engine. Power driven tables are economical where more than 75 engines are turned per day; the cost per engine turned ranging from 2 to 4 cents. This is discussed more in detail in Chapter XXVII.

It is a mistake to suppose that when facilities are inadequate the only thing to do is supply more track room. Merely to "extend" yards or tracks is a practice which cannot too strongly be condemned. Design is more important than car space. It often happens that a terminal with limited track room, but well designed, will permit the movement of more cars in a given time than one having much greater track room. The taxes and interest on the real estate occupied and the material used in construction often form a substantial fixed charge which should be carefully considered. The size of the yard or terminal should be kept to the smallest necessary number of lineal feet of track. It should be planned and constructed so that every foot of track may be used profitably and economically. A mistake in design, requiring unnecessary or expensive movement is a continuous handicap which is difficult afterward to overcome. Like Tennyson's Brook, it "goes on forever."

The study should by no means be confined to the one terminal under discussion. Its relation to other terminals and to the operation of the entire line should be carefully considered and a well-defined and comprehensive policy mapped out. An exhaustive study may show that some yards may be abandoned entirely and others reduced.

Some roads believe that each division terminal should do its own switching—that is, that they should do only such work on trains as will carry them to the next division terminal without further switching. Others start their trains from the system terminals made up to go as far as practicable without rehandling. Each method has its good points, but there are cases where the switching is unnecessarily duplicated. Occasionally these expensive methods cannot easily be avoided because of inadequate facilities at vital points. On the other hand, unfortunately, it is frequently due to officers in charge of general train movements not fully understanding the situation in detail, or failing to take time to study the problem closely enough to arrive at an intelligent solution. This subject is treated at length in Chapter VI.

It may perhaps be assumed that a road is working on a well-defined and carefully thought-out policy regarding its freight divisions. Many instances, however, have passed into history where certain track changes, grade or curve reductions, shop installations, acquirement of additional track mileage, and wage schedule changes, have made it desirable or essential that a freight division be added or eliminated. A change of this kind has an important bearing on the terminals. An expression of opinion should be obtained from the management as to the likelihood of a general revision of division lines or traffic channels in so far as they may affect the terminal situation.

Some years ago an important railroad in this country was operating its main line in five freight divisions. As the physical characteristics and traffiic conditions permitted, it was decided to operate in four divisions, with about 160 miles of line in each. One division disappeared and the operating expenses were materially reduced, but the troubles of the yardmaster began. None of the old terminal yards, except those at the two ends of the road, were of any further service. They represented so much dead track. New terminals were built, but the outlay required for round-houses and the usual accompanying facilities was so heavy that these yards were curtailed. Ample track room was provided in the course of time but until then the trainmasters and yardmasters spent many sleepless nights and the business of the company suffered.

The problem of providing and handling freight at great centers of population and industries, is often perplexing. The general disposition is to put in large classification and train terminal yards outside of cities, purchasing land within city limits for commercial yards and houses only, handling cars between such houses (or team yards) and the classification yards by yard-transfer-engines. Land costing $7 a square foot should not be used for ordinary switching of trains, when suitable sites in suburban districts, usually susceptible to more advantageous development, can be purchased for a few cents per foot. The financial side of the question resolves itself, broadly, into whether the cost of the transfer service (minus the saving by less road train mileage) will be more or less than the interest, taxes, etc., on the excess cost of inside property. The engine houses and attendant facilities should be located near the classification yards and consideration should be given to the probability of objection being raised by municipalities to the "smoke nuisance" and the noise of switching if within city limits.

It is hard to figure on the future and ordinary foresight dictates a policy of preserving or providing the greatest possible amount of elasticity in the terminal. There are two general methods by which this can be done, if permitted by property limitations, physical characteristics, and the size of the appropriation. The first plan is to design and construct the terminal so as to make possible the transfer of work during an abnormal rush of business or an emergency from an overcrowded part of the yard to another part that may not be worked to its capacity. Emergencies may include accidents on the line, a heavy run of business in one direction or of certain kinds of freight, a shortage of power on a certain division, a bunching of power due to various causes, and delayed passenger trains. The other plan, which perhaps is more in the nature of supplement than an alternative, is to design the terminal so as to enable any of the yards to be enlarged at any time. This is a wise course, too, because of the possibility of unforseen changes in traffic conditions.

The doubling of the volume of freight traffic in the past 8 years has made it necessary to limit the size of a yard and add others in series and to avoid yards too large for economical and satisfactory operation. A paragraph in the Pennsylvania Railroad annual report for 1902 indicated this:

> "Experience having shown that yards may become too large for the prompt and economical movement of traffic, these new yards will be used for coal, coke and limestone, and through the relief thus afforded, the Altoona and Harrisburg yards will be amply sufficient for the general merchandise traffic."

The question really resolves itself into "What is the limit in size of a freight-yard unit?" A large number of units can be placed in proximity, provided the entrances and exits are so free that the movement to and from any one unit will not interfere with the others and it is, therefore, the ground available which usually limits the size of a collection of units. A unit consists of a receiving, classification and departure yard, together with car repair, caboose and engine tracks. One set of departure, car repair, caboose and engine tracks often serves two or more sets of receiving and classification tracks. The number of receiving tracks will depend on the density of traffic and liability to interruption from wrecks. After laying out one unit, care must be taken to avoid impairing its usefulness by placing another one so that the movements conflict.

So far as practicable cars should move continuously in one direction from loading point to unloading point. Reverse movements should be avoided, as they cause unnecessary mileage of cars and engines, loss of time to freight, interference with switching and road movements, and additional wear and tear on rolling stock in stopping and reversing the direction of its movement. The expenditure of considerable money to keep the movement continuously in one direction may be justified by the saving in operating expenses.

On double-track roads, the terminal should be located between two main tracks, but this cannot always be done. This principle is shown in Fig. 7. Property limitations, topographical considerations, necessity for handling passenger business in the vicinity, errors in original design, making the cost of revision excessive, and the location of engine-houses and coaling stations, may prevent. Other things being equal, it is desirable at larger division and system terminals to divorce entirely the passenger and freight traffic. Where this can be done it is to the benefit of both, while the consolidation, necessary at times, is detrimental. This applies only to larger points where a reasonably heavy business is being handled. Where traffic is light it is usually economical to combine the freight and passenger business. At large system or line terminals it is of decided advantage to separate the passenger lines from the freight lines some distance in advance of the yards. When the passenger terminals are located near the center of a city, it is often advisable to run the freight tracks around, where yard room can be had cheaper. Better time can then be made with less liability of congestion. If tracks through the city are laid at street levels, the advantage of such an arrangement is apparent. The objection to separating main tracks around terminals—that enginemen cannot read signals carried by engines on trains in the opposite direction—is not a material one. Where such an arrangement of tracks exists, the entrances and outlets at either end of the terminal should be protected by operators in charge of interlocking plants, and outgoing trains should be governed by signals given them. By the separation of the tracks there is a minimum of interference through cross-over movements. Freight and passenger trains in the same direction use the same tracks,

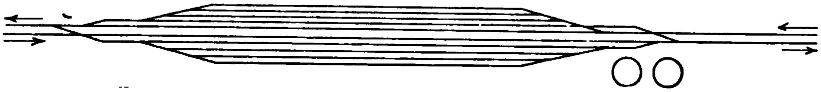
FIG. 5.—Main tracks through center of terminal—Yards opposite each other.

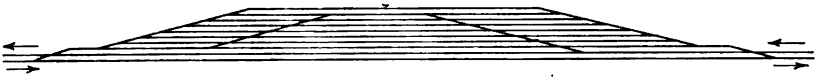
FIG. 6.—Main tracks to one side of terminal.

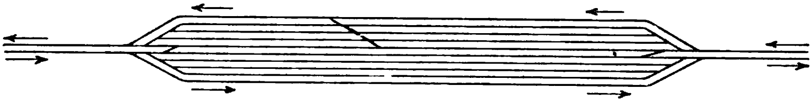
FIG. 7.—Main tracks separating and outside of terminal.

and no connection with passenger tracks need be made except at the two ends of the terminal or at the point where the four-track system converges into double track. But one side of the passenger train is exposed to the possibility of entanglement with accidents occurring on the yard tracks next alongside. This is a safer arrangement than dividing the terminal by having the passenger or high-speed tracks run through the center, as shown in Fig. 5. In this plan, yard engines in charge of hostlers or going to or from their freight trains need not come in contact with or cross the high-speed tracks. Conversely, passenger trains cannot interfere with the movements of freight engines or detain them.

When the high-speed tracks, for any reason, cannot be run around the terminals, the next best plan is to run both on one side, as shown in Fig. 6. As compared with the preceding arrangement this is open to the objection of compelling freight trains moving in one direction to cross the passenger tracks in the opposite direction when entering and leaving the terminal. It will be seen that this will frequently compel freight trains to be stopped for passenger trains in the opposite direction, causing some detention and considerable expense. But one side of passenger trains in one direction is alongside of a yard track. As in the previous plan, the advantage exists of enabling interior terminal movements to be made from any yard to another, to or from engine-houses, etc., without interference with high-speed trains. Both plans have the decided advantage of enabling a transfer of work from one yard to another when one part of the traffic runs abnormally heavy or when emergencies arise. These transfers can be made without encountering the high-speed track movements at any point. The advantage of this is that a class of enginemen can be employed who may not be permitted to go out on the open road because of lack of familiarity with train rules. Such men are always at hand and in times of a heavy rush of business or abnormal conditions, it is usually difficult to secure men who can run on the main line.

To run the two main tracks through the center of the terminal, dividing the east or southbound side from the other, is often the only alternative, and doubtless there are more terminals operated on this plan than there are of the other two combined. The liability to accident is somewhat greater under this arrangement and there are many objections which have been briefly reviewed. There are, nevertheless, many who favor this plan as against running the two passenger tracks on one side because of the necessity of crossing movements in the latter. These movements exist in one form or another, however, as the engine-houses, coaling plants, repair tracks, etc., are usually located on one side and cross-over movements are made necessary for road engines to or from the engine-house, cabooses to be returned from the direction in which they arrived, and cars moving in one direction to be repaired.

Where a four-track road uses the two middle tracks for freight, these should be separated to permit of the location of the yards between them. The Pittsburg, Fort Wayne and Chicago remodeled its Conway yard to accomplish this. Interference with passenger traffic had become annoying. With the high speed tracks in the middle they are usually run through the center of the yard. To avoid interference with switching and crossover movements, it would then be necessary to elevate the passenger tracks and establish yard connections beneath. "Jump-overs" are used to avoid interference; the passenger tracks crossing the eastbound freight track by a separation of grade levels.

It is important, before proceeding with the plans for a terminal, to make a study of traffic conditions as they exist and as they will probably exist years hence. After this has been made as accurately as may be, committees should be appointed and a study of all conditions made. An examination of available plans of yards already in operation or in course of construction will be valuable. With this information a summary should be made of the number of cars moving to and from each of the divisions centering in the terminal and to and from the industries and other unloading points. These figures should show the number of loaded and empty cars and the number of trains, from which a tabulated statement may be worked up, including the average and maximum number of cars to a train in each direction. In some cases it may be well to go into greater detail as to the number of cars in a train, tabulating for each division and each direction, the trains with fewer than 10 cars, those between 10 and 20, those between 20 and 30, etc. Figures of movements during certain hours or periods of the day may be advantageous. From these data a fair estimate may be made of the capacity needed for each receiving, separating, classification and departure yard and the length and number of tracks required. Consideration should also be given to the possibility of adopting a different class of road locomotive on any of the divisions; or of a transfer or an exchange of power which may affect the length of trains hauled.

Notwithstanding the fact that no two terminals can satisfactorily be constructed on the same plans, and that local conditions govern largely, there are a few general principles which should be considered and which may be applied wholly or in part to the design of any terminal.

In many plans of typical terminals, the yards for each direction lie alongside of each other. This arrangement is objectionable in that the engine-houses, coaling plants, ash tracks, and repair tracks, must be inconveniently located for one yard, or must be duplicated. An engine coming in from a westbound train must travel to the east end of the eastbound yard to get its return train; and a similar movement in the opposite direction must be made by the engine arriving on an eastbound train. By locating the yards so that they will "head in" on each other (see Fig. 8), *i.e.*, having the west end of the westbound yard terminate near the east end of the eastbound yard, the engine-houses and attendant facilities can be located where they may be readily reached by incoming engines from either yard, and the facilities for caring for engines may be concentrated. This applies also to the organization of the employees. It reduces the engine mileage and cuts out the running tracks needed for engines going to and from their trains. The caboose tracks should be located where the cabooses will not be disturbed in switching, as the men frequently use them for sleeping quarters. As some crews are usually assigned to regular or preferred runs, such as fast freights, local or work trains, it is desirable to have two caboose tracks, and they should preferably be located near the outlet end of the terminal to enable the pooled or "first-in first-out" crews to drop their cabooses to the rear of outgoing trains. The writer has, nevertheless, recommended the construction of classification yards for two directions on the opposite principle, *i.e.*, heading the yards away from each other. The topography thereby enabled the utilization of favorable grades to aid switching for both yards while the principle explained in Fig. 8 would have caused these grades to oppose switching.

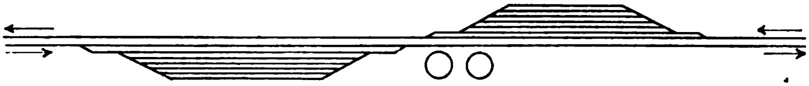
FIG. 8.—Main tracks through center of terminal yards on "lap" principle.

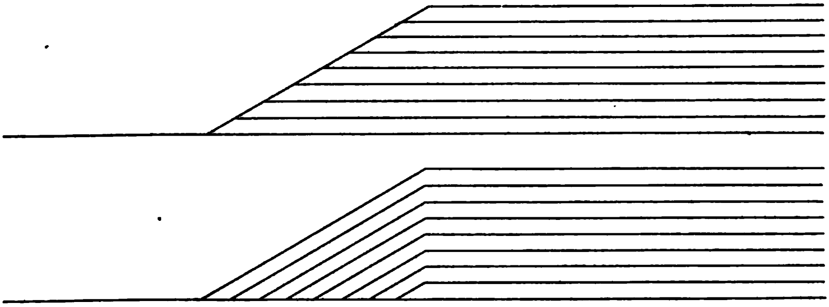
FIG. 9.—Types of grid-iron ladders.

The location of terminal yards should be convenient to the business terminal of the railroad, to the freight-houses, team tracks, and to the points of interchange with other roads or divisions, and should be arranged so that trains can enter or leave the yard without crossing the path of other movements. When possible, advantage should be taken of natural grades to assist switching. In some locations, assisting grades cannot be had; in others, grades can be had in one direction; while in others, grades can be used to help in each direction. The assistance of grades is a great advantage.

In the foregoing a yard with reference to the movement of traffic in one direction only has been considered. For movements in both directions a duplication of yard facilities would, of course, be required. A segregation of the component parts of a terminal in logical sequence follows:

Receiving Yard.—Considering first a terminal at the actual end of the line; in the receiving yard, the road engines and cabooses are cut off and the work of assorting and distributing the cars is turned over to the switching engines and the crews. The proper length of tracks depends on the unit selected and is governed by the following factors:

1. Length of train of loaded cars.
2. Length of train of empty cars.
3. Average length of trains.
4. Number of trains of average length per day.
5. Number of trains of maximum length per day.

Consideration should also be given to prospective changes in grade and to a possible increase in the length of trains entering the yard. The length of train is the controlling factor and the logical unit. When the number of trains of maximum length is less than 20 per cent. of the total number of trains entering the yard daily, the average train length is the most practical basis for a receiving yard having tracks of equal length. The yard may, however, be made with a portion of the tracks of sufficient length for maximum trains and the remainder of the tracks of sufficient length for average trains. In this case the tracks of each group should be of equal length, whichever unit (the maximum or the average train) is taken. The tracks should be of such length as to accommodate a train with two engines and a caboose. If the average train length is taken as a unit, the length of track should be such that a train of the maximum length can be disposed of on not more than two tracks.

The proper size of a receiving yard depends on:

1. The frequency of the arrival of trains.
2. The rate at which cars can be received and disposed of in the separating yard. The receiving yard, however, should have a sufficient number of tracks to hold the trains arriving during 1 hour of maximum traffic.

Separating Yard.—This yard is the second in the series and here the first breaking up of a train and the distribution of its cars are effected. The cars entering the yard are usually distributed so that according as the separations are to be by districts or commodities, the cars destined to assigned districts or containing the same commodities will be placed together on separate tracks. The yard should be located in advance of the receiving yard and in such a way that cars can readily be moved into it. The number of tracks in the separating yard should be governed by the number of separations to be made. The length of these tracks should be determined by the number of cars for each separation and there should be extra room allowed for emergencies.

Classification Yard.—When the separation in the preceding yard is by districts, the purpose of the classification yard is to put the cars of the different districts in regular order. The cars of each district (already placed on one of the tracks of the separating yard) are switched in the classification yard in the order required for delivery at destination. When the separation is by commodities, the cars of each commodity (already placed on one of the tracks of the separating yard) are further assorted by classes or grades. Thus, all the cars of grain placed indiscriminately on a track in the separating yard will be rearranged in the classification yard so that the cars of wheat, corn, oats, etc., are each grouped on separate tracks. The classification yards should be located in advance of the separating yard, in such a way that cars may be readily moved into it from any of the tracks of the latter yard. It is usually in the form of a gridiron (see cuts, Fig. 9) and its capacity will be determined by the number of cars going to a district, with allowance for an excess number or for emergencies. As an example; with 36 cars going to a district, two gridirons of six tracks each with a capacity of six cars to a track will give such control to the entire set of cars that it can be turned end for end, or car for car. This type of yard may be made up of a series of parallel stub tracks instead of gridirons. Such an arrangement is sometimes termed a "lancing yard."

It is well to avoid unusual length of classification or assorting tracks, and where the classifications are numerous no attempt should be made to provide a track for each classification. In such cases a second classification yard beyond the first, reclassifying from one of the tracks of the first into the second yard, would be a wiser plan, unless a yard of enormous proportions is planned. With a "V" ladder possibly 30 to 36 tracks may be economically used, one-half running from each ladder, but in practical working it may be desirable to reduce the number to about 20 tracks and reclassify into a second yard. The long ladder increases the distances cars must travel in switching. (See Fig. 10.)

Departure Yard.—Here the work of the yard engines and their crews ceases and that of the road or transfer engines and their crews, is begun. It should be located in advance of the classification yard, so that cars from all tracks in the latter can be readily moved into the departure yard. The number of tracks and the length of tracks in this yard are governed by the same requirements as the receiving yard.

Storage Yard.—The location is important and depends almost entirely upon the character of the cars to be stored or held. Three distinct cases may be mentioned:

1. On some railroads it is known in advance that entire train loads arriving will have to be held. In such cases the storage yard should be located with, or held in close relation to, the receiving and separating yards so as to permit of direct movement of trains to the storage yard and then to the separating yards as required.

2. The cars to be held may arrive mixed in with cars that are to go forward. In such cases the storage yard should be located in relation to the separating yard so that the cars can be moved directly into the storage yard from the separating yard and then delivered to the classification yard as required.

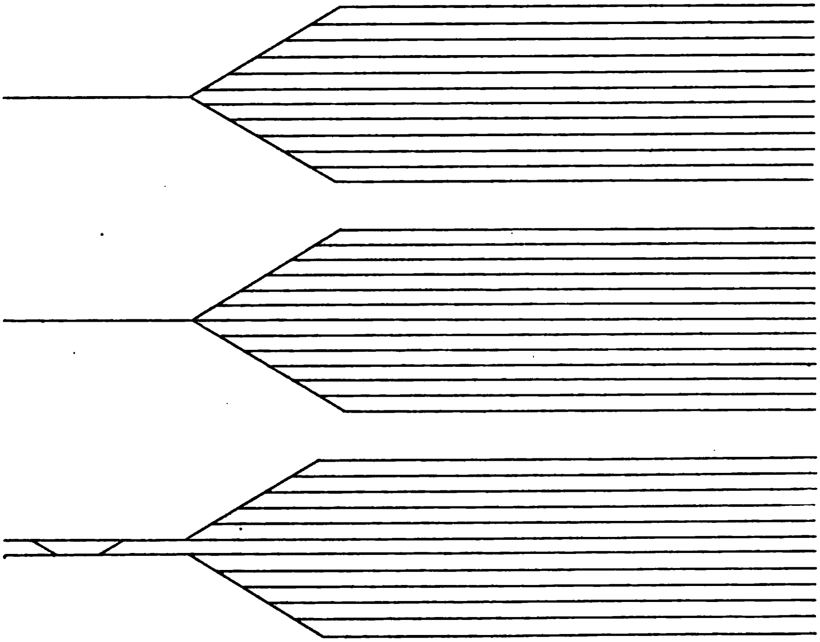

FIG. 10.—Types of V-ladders.

3. The character of the freight to be held may be such that it can be put in district and station order at once. In such cases the storage yard should be so located in relation to the classification and departure yards that cars can be moved directly into the storage yard from the classification yard and then delivered to the departure yard as required.

There are probably other cases, but the three principal ones mentioned indicate that the location of the storage yard cannot be determined arbitrarily or theoretically. It must be determined by the character of the business in each case. The size should be governed almost entirely by the number of cars to be held, and the length of the tracks should be such that a switching engine can readily handle all the cars stored on one track.

Transportation officers dislike the term "storage." It is often argued that yards and tracks should be built for movement, not storage. Because of conditions they cannot control (many due to traffic department requirements) they find storage tracks not only useful but necessary. To meet purely operating conditions, little storage room would be required.

Body Tracks.—These should be spaced 11 ft. 6 in., to 13 ft. center to center, and while the minimum spacing is not recommended for general use, it is often necessary in city yards. Curves should be avoided. At intervals of five or six tracks an extra width of spacing should be given in order to allow space for drainage and for piling track material, etc. It is also advisable to allow a space of 15 ft. between the center of a main track and a yard track, to give ample space for water columns or standpipes, signal posts and other similar requirements.

Ladder Tracks.—Where there are two ladder tracks or where a yard track parallels a ladder track, these tracks should be spaced 15 ft. center to center. The extra room is required for the safety of trainmen in throwing switches, and moving in and out between the cars. The angle which the ladder track makes with the body tracks should be the greatest angle which the frog used will allow. A No. 7 (8° 11′) should be the minimum number of frog for yard use.

By continuing the curve of the switch lead about 10 ft. beyond the frog, No. 8 frogs can be used on a No. 7 ladder or No. 7 frogs on about a No. 6.5 ladder, thereby saving track room and at the same time giving easy switch leads.

The arrangement of the ladder tracks demands careful study. The ordinary gridiron ladder is simple and satisfactory, but where more capacity is required the "V" ladder (Fig. 10) may be used to advantage and gives a larger scope to be reached by one lead. Twenty tracks may be reached comfortably from a "V" ladder; as a maximum, 30 to 36. Any increased length of ladder brings about much lost motion and increased distance to be traveled by riders.

The central ladder (Fig. 11) is advocated and has its advantages and disadvantages. On it are two curves to be turned by the car before reaching the deflecting switch on the ladder. The car that does not run freely is therefore retarded shortly after obtaining its start, which necessitates a heavier descending grade. The ladders are ordinarily higher than the body tracks, to secure the essential gravity movement. An advantage in drainage is consequently had and the water is easily carried away from the ladder tracks and the switches. The ladders being in a direct line, at all times in view of the cutter (the employee who parts the cars), he is enabled to work to better advantage than when his view is occasionally obscured, as with other ladder designs. The compact location of switches enables them to be handled more economically if thrown by hand and, if handled mechanically from a tower, a much better view will be afforded. The central ladder may reduce crew expense, as trainmen may be available for service on either side of the yard as soon as they reach the ladder, while under the usual "V" ladder they are not always in readiness for cars going to the opposite side until they have reached the distributing point at the head of the yard. The open space between the ladders permits locating electric light poles at a point where light is most needed and where a minimum number of lights will suffice. Where heavy snow storms are encountered, this ladder possesses advantages on account of its higher location and consequent freedom from drifting.

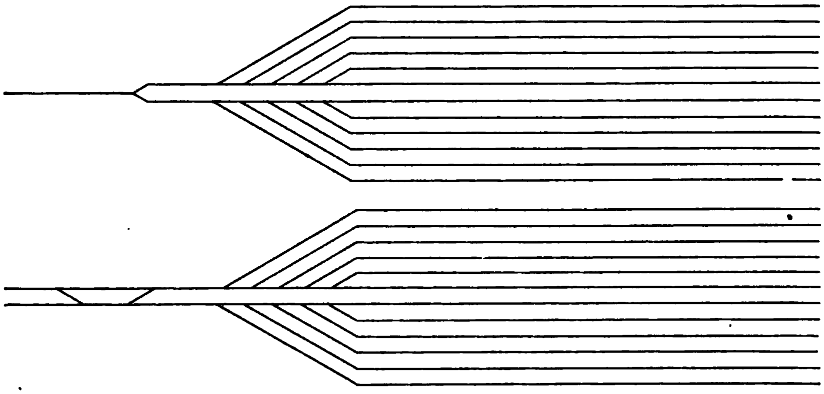

FIG. 11.—Types of central ladders.

There is probably no large yard where the central ladder scheme has been tried. The flexibility by which the "V" ladder capacity may readily be extended to meet increasing traffic demands, is lacking in the central ladder. With the "V," two or more leads may be operated. It is contended that on the central ladder arrangement cars run more freely because they do not reach the curves until they have attained some headway; but this is more than offset by the additional curvature introduced.

Lead Tracks.—The connection of these tracks with the main line should be controlled by a telegraph or telephone office and interlocking plant, both for safety and to facilitate train movements. The most efficient guardian is the interlocking plant. Main track movements should not be permitted indiscriminately. Yard engines should only be allowed on main tracks when properly protected by interlocking and other signalling.

The late Walter G. Berg said:

"Another important point is that trains that are to go into the yard or leave it should make those movements quickly. They should be got off the main tracks promptly when entering the yard. It is important to have approach tracks leading to the yard. The great mistake usually made is that the yard lead track turns out of the main line track. There should be an approach track or lead-in track approaching the yard switches proper, long enough to accommodate at least one train, so that if a freight train is just able to make the yard ahead of a passenger schedule it can turn into the lead-in track quickly without having to slow down, or without fearing to meet possibly a switching engine or some yard operation and have to block the main line for a considerable time.

"Similarly at the departing end of the yard it is very important, especially when there is not a system of yard tracks known as a departure yard or advance yard, to have a track leading away from the yard out along the main track for some distance. There are cases where this lead-out track has been extended several miles advantageously. It means that when the train is boarded in the yard ready to leave, it is pulled out slowly into this lead-out track and goes out of the yard and away from it and then stops with the nose of the engine at the signal tower, at the head of the lead-out track, and when it gets the board it can rush out on the main line and make a quick run and get out of the way at the next passing siding."

Drill Tracks.—These tracks should be so located as to cause a minimum interference with other movements.

Open Tracks.—The track selected as the open track should be one that will enable movements to be made from one end of a yard to another with the greatest convenience.

Running Tracks.—Tracks of this class should be provided for movement in each direction, to enable yard engines to pass freely from one portion of the cluster to another, also for road and yard engines to get to and from the engine-house and other points where facilities are located.

Caboose Tracks.—Cabooses arriving at a yard ordinarily return over the same division instead of going forward. It is usually necessary, therefore, to locate caboose tracks between the receiving yard and the departure yard and to arrange them so that the cabooses can be readily pushed from a receiving track to the caboose track and then dropped by gravity to a train departing in the direction from which the caboose has arrived. There are various ways in which this can be accomplished, but in locating these tracks care should be taken that only a minimum amount of switching will be required. The tracks should be so arranged that cabooses feed "first-in first-out." Occasionally special tracks must be provided for the cabooses of fast freight trains.

Scale Tracks.—These are usually located between the receiving and separating yards. It is undoubtedly the best location for automatic weighing because no reverse movements will be required in taking the cars on and off the scale.

The scales should be located on the lead over which all cars are passed on their way to the ladder of the classification yard. They should in every case be provided with a "dead track" to avoid unnecessary strain on the scale bearings. If but a small proportion of the cars needs to be weighed, or if only cars for a few tracks in the classification yard are to be weighed, the scales may better be located on the ladder of the classification yard in advance of two, three, or half a dozen of the body tracks, as circumstances may require. If but very little used, they may be placed on a short body track well back from the working part of the yard. There is a disposition to make scales too long rather than too short. The long scale is objectionable as it necessitates keeping cars far apart, which delays switching.

Coal, Ash-pit, Sand and Engine Tracks.—The engine coaling apparatus is usually located on the track leading to the engine-house. Water and sand should also be taken at the same time as the coal, where this arrangement is possible. The facilities for supplying coal, water and sand are sometimes provided on the out-going engine-house track, as well as on the incoming track. It will be of advantage to provide a run-around track, so that switch-engines may clean fires, take coal and water and pass around waiting road engines.

Bad-order Tracks.—These are required so as to get the bad-order cars out of the way of the switching movements. They should be arranged for easy access at all times. From them the cars are taken to the repair shops.

Repair Tracks.—These should connect with the bad-order tracks where practicable. Their capacity should not ordinarily exceed 15 cars. These tracks should be located at points where cars can be run directly into them from the receiving yards, the same as other cars being classified. The usual method, and that prescribed by the rules of the American Railway Association, is to place an inspector's blue flag in advance of the cars being worked on. This is to prevent engines or cars from coming in contact with the cars on the repair track and possibly injuring the men under or about them, engaged in repair work. A better and safer plan is to put special locks on the switches of one-half the repair tracks, letting the foremen of the repairers alone have possession of the key. The yardmen will then put cars in one-half the tracks while the repairers are working on the other half. When the cars are ready to be taken out the foreman removes the special locks and places them on the switches of the tracks last filled, enabling the yardmen to pull out the cars repaired and make room for placing other bad-order cars. To hold not to exceed 15 or 20 cars each, tracks longer than ordinarily designed for that number of cars are required because bad-order cars are usually separated several feet to give repairers an opportunity to get around them conveniently. They should be laid in pairs, about 16 ft.

center to center, and a clear space between each set or pair, of about 25 to 30 ft., for placing and handling material. A narrow-gage track may be laid in the wide space and small trucks for handling material run thereon. Small turntables are used to connect them at one end of the repair yard to a cross track leading to the material yard and supply house. The writer has had two or three tracks set aside from the body tracks of a separating yard to be used for light repair work. These were planked over to enable wheels to be rolled and material handled. One track was cut out for material, including wheels. This arrangement worked very satisfactorily as it saved time in movement of cars and switching and it relieved the regular repair yards of light work which interfered with making heavier repairs. In one yard a track alongside of the repair track was reserved for repairs to cars in fast freight and stock trains and this prevented and reduced many delays. Wheels were put under stock cars in 20 minutes without any special exertion and cars were forwarded in the same train in which they arrived. Under the old method they were taken over to the regular repair yards and forwarded by a later train. This usually resulted in 6 or 8 hours' detention and at times twice as long.

Icing Tracks.—These should be between the receiving and separating yards, so that the cars to be iced may be readily moved from the receiving yard to the icing track and thence to the separating yard.

Other Special Tracks.—The particular purpose for which such tracks are required should be considered and they should be so located that their use will involve a minimum amount of switching and the least possible interference with the regular yard movement.

Air Plants.—An air testing plant is essential in the departure yards of each terminal. Here brakes may be tested, all leaks closed, repairs made and auxiliaries charged with full air pressure before the road engine arrives. Much valuable time of engines and crews may thus be saved. Such a plant is particularly desirable since the passage of the Safety Appliance Act with its requirements as to the control of trains by air brakes. Brake apparatus can be maintained better and trains will be started out in safer condition than when the repairs are made hurriedly after the engine has coupled to the train and pumped up the pressure in the main train line and auxiliaries. Usually the repairs are neglected when the men are hurried. The cars on which brakes are non-operative are either cut out and air worked through—a very bad practice—or the cars are switched out and put in the rear of the air-braked cars. This causes the loss of the braking power of those cars and delay to road engines and crews while the change is being made. After this switching the air again has to be tested. A testing plant is not very expensive. Usually one line of pipe can be run from the compressor across the end of the yard, and connection made with a hose coupling between each pair of tracks, two tracks being reached with each coupling.

Engine Facilities.—Engine-houses and the coaling plants, sand plants, ash pits, water stations and turntables should be located in such a position as to prevent movements of engines to or from them or from one part to another, from being blocked by the movements of road trains or yard engines. In some yards it is necessary, unfortunately, to have these light engine movements cross the main tracks. Where this occurs, the engines should be in charge of regular road runners and the movements should, if practicable, be under the control of interlocking plants. Where the terminals for the two directions are on the "lap" plan, or head into each other, the engine-houses, etc., can advantageously (at the lowest cost and with a minimum of delay) be concentrated at one point to serve engines from two or more divisions. The usual movement for an engine coming in from the road is to go to the ash-track first and have its hoppers dumped and fire cleaned or drawn. A hostler has a better opportunity to work on the fire when the tender is empty because then he has more room in which to use the long handled tools. Then, too, if the fire is to be drawn for washout of boiler, repairs or other reasons, the engine is not loaded up with a tank of coal which may not only be in the way and prevent repairs to the tender, but is objectionable in other respects if the engine is to be laid up. The writer once saw several steel tired wheels completely ruined after having stood under a tender loaded with bituminous coal for two or three months. Rain had run through the coal and caused a constant drip of water containing sulphuric acid which cut considerable depressions into the steel tires and necessitated their removal. The ash-track is usually elevated, sometimes on columns, and has a depressed track alongside for empty cars into which the ashes are loaded.

The engine's next movement is from the ash-track to the coaling plant and it should either take sand and water while taking coal, or at some convenient point close by. In some cases engines have their fires cleaned and ashes drawn while taking coal, a conveyor system being used for elevating coal as well as removing the ashes. The engine is then run over the turntable and, if necessary, into the round house. The movements from round house to coal plant should not conflict with those in the opposite direction.

While the above is an outline of the usual handling, it is just the exception to the rule that is the disturbing element in handling engines and in all transportation work. An engine is needed for an assigned run; it may be a fast freight or stock train. A passenger engine is required ahead of freight engines. Even the yard engine with its crew waiting in idleness may demand preferred attention. In such cases it becomes necessary to run an engine around others and out of its turn. This results in a corresponding or greater delay to other engines to be handled. The arrangement for handling cabooses in turn may be similarly broken up. The fast freight train takes precedence on the road over trains of more weight and frequently of greater value and earning power. It is necessary, therefore, to locate the ash-tracks, and other engine facilities, in such a position as to enable one engine to be run in ahead of another. To this end the facilities for cleaning fires, coaling, taking water, sand, etc., may be advantageously located so they can be reached either from the outgoing track or the return track. A depressed track under a switching summit may be utilized to enable light road engines to cross from one side of a switching yard to the other without interfering or being interfered with. This idea may well be given consideration in connection with the design or revision of a busy terminal. Tracks used for engines exclusively require little overhead clearance and comparatively steep grades may be introduced to attain the very desirable condition of free and uninterrupted movement of road power. Loss of use of road power during "rush" seasons is extremely costly. Its value at such times is many times greater than when lying on sidings "white-leaded" awaiting a freight movement and it is just at such times that terminal delays in the handling of power are most excessive and exasperating. Every facility should be provided to take care of engines promptly during heavy traffic periods and to prevent yards from choking up at such times. All calculations for terminal work and work elsewhere should be made to meet the requirements of the months of heaviest traffic movements. It may be wiser, in places, to base calculations on the *heaviest day's* movement. The remaining days will then have been provided for.

Telephone service connecting telegraph offices, interlocking stations, engine-houses, crew dispatchers' and yardmasters' offices with each other is essential. A local exchange is convenient and a money saver.

Electric lighting should be carefully planned to give ample light and. avoid throwing shadows, especially along ladder tracks and switching centers.

The yardmaster's offices should be located in the most central point available and preferably in a building two or three stories high, to enable him to get a fairly good view of his yards. Separately, or in connection with the yardmaster's building, a room should be provided for yardmen to eat their lunches. Another room should be provided with a sufficient number of lockers, with wire screened doors for ventilation (one to each employee) so that the men may change clothes before reporting for duty and after finishing work. Buildings of a suitable character and at the most convenient points, should also be provided for car inspectors and repairers and for their materials.

Rest Rooms.—If there is no Railroad Y. M. C. A. or men's club room one of the best investments to be made is a good and well kept bunkhouse for road crews. This should be located at a point where men can be called quickly as needed, but where it is also sufficiently quiet for them to obtain rest. The cost of building and maintaining a house of this kind is comparatively small and affords substantial returns in better service from men who have actually rested and are in condition to perform their duties satisfactorily. It also keeps them away from their cabooses which, for many reasons, are not desirable bunk-houses while lying around yards; and from the usual accompaniment of the cheap boarding-house, the bar-room attachment. A day and night lunch-room, near the bunk-room, is desirable and can usually be made self-sustaining, but no attempt should be made to have it earn more than running expenses.

The following excerpt from a report (January, 1903) made by a committee of the American Railway Engineering Association, aptly summarizes the various phases of yard work and indicates its importance in relation to the railroad's main function—the economical production of transportation:

> "The actual practice in the methods of operating the switching traffic, or switching movements of such yards and terminals, varies at different yards, owing to the local conditions of yard plans and traffic. The proper handling of traffic is largely a matter of individual ability, and must be governed to a large extent by the peculiarities of the traffic and the physical characteristics of the yard. For these reasons, therefore, the operation of the switching traffic can only be dealt with in a general statement.
>
> "A terminal is composed of the facilities of a railroad in a city for handling its business and usually embraces all the tracks and facilities. The distance from the large general yard or cluster to the docks, wharves, freight-houses, team tracks or other facilities is in some cases as much as 15 or 20 miles. This territory is divided into districts, for convenience in switching and for the assignment of switching crews. Each switching district is usually provided with a small switching yard, from which the various private side tracks, freight-houses and manufacturing establishments in the district are supplied with their cars. The district yard is supplied and relieved by movements to and from the cluster to the general yard. These latter are made by what are termed 'transfer crews.'
>
> "The movement of a train after its arrival at the general yard or cluster where the engine and caboose are detached, is as follows: At large terminals the cluster is usually several miles from the city and is the point at which all trains are received and dispatched. The manifest of the train is taken by the train conductor to the yard office immediately upon arrival; from this manifest a card is prepared for each car in the train, by the train-carding clerk. These cards are prepared and turned over to the car carder, who takes them to the yard and tacks the proper card on one or both sides of the car. The cards have various colors, shapes, letters, monograms, marks, etc., designating the various districts to which the cars are to be moved. While the cards are being prepared and attached to the cars, the cars are inspected by the car inspector, so that they are ready to be moved as soon as carded.
>
> "A yard engine and crew now takes the cars in charge and classifies them, either by drilling, poling or pushing them over a summit, thus putting the cars for each district on the track in the separating yard assigned to that particular district. After completing this work the engine in question commences work on

another train. The conductor doing this work keeps no record of the cars handled. The next engine to handle these cars is what is known as a 'transfer engine' and makes what is termed the 'interior and exterior' movement of cars; that is, movement from one yard or district to another (interior), or to the yards of various other railroads (exterior). When this engine takes a train to the district yard or to the yard of another railroad, it has nothing more to do with the train and may return light to the cluster. If there is a return load at the yard in question, or a load can be picked up on the way back, this engine handles the movement. It sometimes happens that one of these engines will have freight for two or more districts as it proceeds. After the freight arrives in the district in which it is to be unloaded, some of it is held for orders of consignee, while other freight of the same lot may be switched to consignee without waiting for orders. That lot for the freight-house and team tracks, if there is room for it, is delivered immediately, or as soon as convenient after arrival. That part of the freight consigned to industries, for which there may be a number of other cars that have arrived previously, will be held and placed in the order of its age, or ahead of its turn, according to the wants of the consignee. These latter movements are all made by the district switch engine; that is, the engine working in that district and doing the local switching.

"At nearly all clusters or general yards quite a large percentage of the business arriving consists of what are termed 'hold cars'; that is, cars which are to be held at the outer yard until final destination or switching directions are given. On arrival, these cars are switched to the 'hold' yard and are daily reswitched in order to take from among them the cars for which directions for delivery have been received. When directions are received the cars are carded and treated just the same as cars which move directly to destination. The 'hold' car is a great nuisance, as large roads will frequently have 500 or 600 'hold' cars and receive orders daily for 50 to 100 of them. These must be switched out from the entire lot, entailing a large amount of work.

"The movement in the reverse direction is made in practically the same way as the movement from the general yard or cluster to the industrial districts; that is, the district engine gathers up the cars for movement, a transfer engine takes them to the general yard, where they are switched to the outbound or classification tracks. Here the trains are made up in station order, the bills are prepared by the yard clerk and the road engine finally couples on and the train is complete and ready to leave.

"At larger terminals, in order that cars may be readily located and not get lost, a record is kept as follows: The conductor of the road engine brings the train into the general yard or cluster and fills out a card, giving number and initials, kind, lading and condition of seals of every car in the train. The conductor or foreman of the transfer engine fills out a card, stating whether loaded or empty and the point at which set off or picked up. The district switch-engine conductor makes a similar record for all cars moved to and from large industries. These cards are forwarded at once to the car record office and entered in the car record book, so that the record of any particular car may be found in the book by turning to the number of the car. Thus it may be found that it arrived at the general yard or cluster on such a date and moved from the district yard to some industry on a certain date. The record may also show that the car has been reloaded from this particular industry and again moved to the general yard; or, if it does not show movement from the industry, the car is still on its tracks. Thus the location of any car at a large terminal may be ascertained in a few minutes.

"In the movement of outbound freight the cars are carded by the district or local yard clerk, who works under the direction of the local agent. The agent prepares memorandum bills, which are sent by train-mail or messenger to the general yard. At this point the bills are taken in charge by the yard clerk, who checks the train and prepares the train list and bills for the conductor, a bill or manifest being furnished to each car in the train.

"The movement of transfer engines, especially those working from the freight-houses, is made on regular schedules. This is done so that immediately on closing the freight-houses at night, cars are moved from them into the general yard, and cars for morning delivery are at the freight-house before they open for business."

CHAPTER IV

TRACK CONSTRUCTION AND MAINTENANCE DETAILS[1]

Passing Sidings.—Sidetracks used for train service as distinguished from those used for storage or for switching movements are often termed passing sidings because their function is to permit trains to pass one another on single or double tracks and thereby to relieve traffic. While it is necessary that passing tracks shall be connected with the main tracks and often by the introduction of facing point turnouts, still it is not good practice to connect many switching and industry tracks to the main track, but rather to connect them to a lead track which in turn is connected with the main track, preferably at both ends, and thereby avoid many switches on the main line.

In single-track operation passing sidings are frequently arranged as in Fig. 12. Design (a) places the outgoing turnouts directly before the eyes of the towerman. In such an arrangement two trains headed in opposite directions on the two sidings may proceed after the main line train has passed without waiting for each other's movement. If the sidings are long enough to accommodate two freight trains the second freight can follow up the first one and wait at the tower for orders to proceed. Plan (b) shows another less desirable arrangement for double siding. Design (c) is a single siding long enough for two trains, with crossovers located near the middle of the siding connecting it with the main track so that if both are headed in the same direction, either train on the siding can pull out first on to the main track; or, if both are headed in opposite directions, then both trains can pull out on to the main track as soon as the main line train has passed.

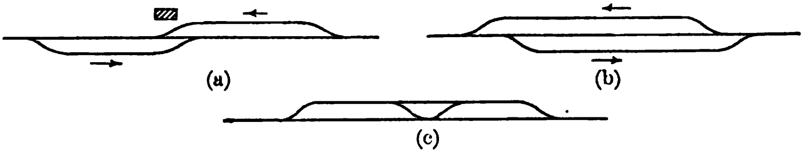

FIG. 12.—Passing sidings on single track.

Similar designs for passing tracks adapted to double main-track operation are shown in Fig. 13. In design (d) the single passing track between the main tracks can be used for a train or trains in either direction; it is a convenient arrangement for approaching trains but awkward for departing trains when there are two trains on the siding.

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[1] This chapter was written by Charles B. Breed, Associate Professor, Civil Engineering, Massachusetts Institute of Technology.

Plan (e) is simple but not flexible. Plans (f) and (g) are well adapted for handling traffic from a tower located near the crossover.

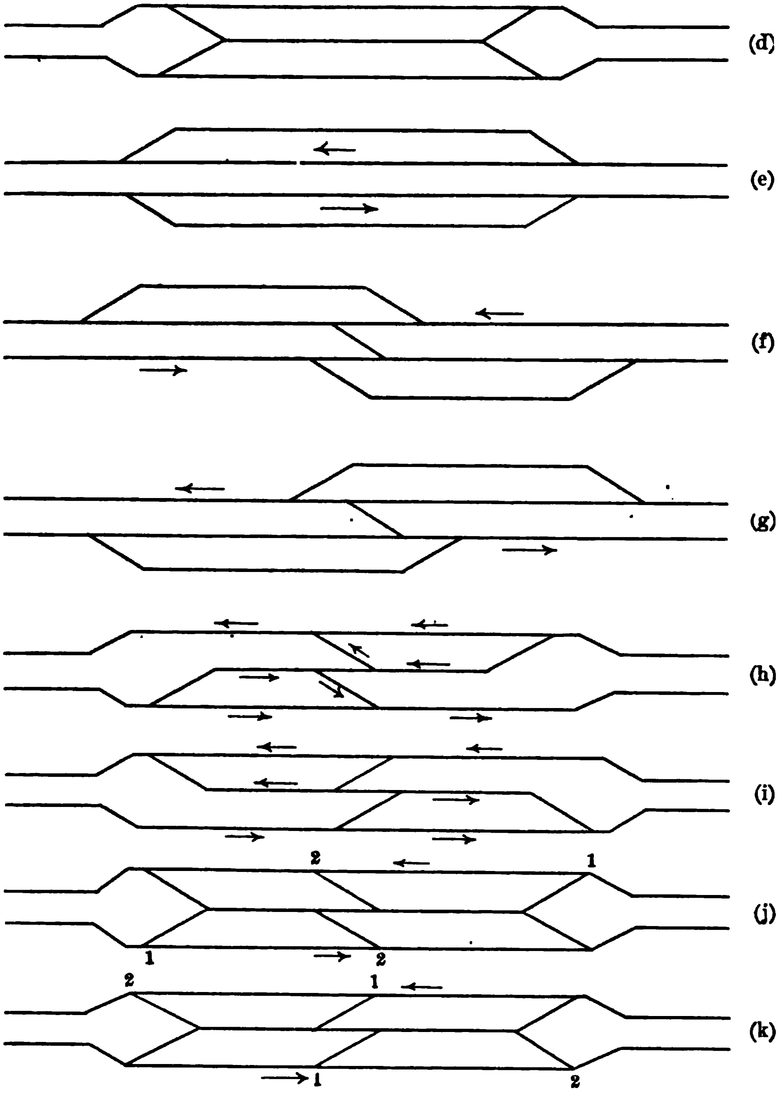

Fig. 13.—Passing sidings on double track.

Schemes (h) and (i) are similar in operation to (f) and (g) but have the disadvantage that curves have to be introduced into the main track. In (e) (f) and (g) it will be noticed that both main tracks are straight whereas in the rest of the designs they have been spread apart to admit constructing middle sidings. Where the main tracks are thus spread apart in some instances it is possible and good practice to preserve one of the main tracks straight and put all of the curvature into the other one rather than to move both of them half of the total amount of spreading required.

Plans (j) and (k) present the most flexible arrangement of passing sidings; the tower should be located opposite the middle crossovers. As a rule trains will operate through this arrangement by pulling in at point 1 and out at point 2.

The turnouts of passing sidings should be equipped with interlocking switch and signal apparatus operated from a tower, which should be one of the block signal towers where manual block signals are used. The tracks of passing sidings should be spaced 16 ft. on centers wherever possible.

Industry Sidetracks.—Industry tracks are, whenever possible, designed as trailing turnouts rather than facing point turnouts. In fact, it is not uncommon for a railroad to refuse to construct industry sidetracks requiring facing turnouts leading out from the main track. It is the growing practice in large cities to construct parallel to the main track an industry track connected at both ends to the main track, and to this lead track all of the industry tracks are connected. Since the operation of cars over this lead track is in all cases slow and is freight service only, there is little necessity for concern as to whether or not a sidetrack requires a facing or a trailing turnout. In many cases of industry tracks the physical limitations are such that the track must contain very sharp curves, unusual frog connections with the lead track, and in many instance special track construction is required. As a rule a sidetrack which has a down grade toward the main track should not be constructed, but with proper derailing devices which are mechanically interlocked with the switch of the turnout even such sidetracks can be made substantially safe so far as main line traffic is concerned. Grades of 3 per cent. are not uncommon on industry sidetracks where but few cars are to be handled at one time; it is common, for example, to have grades of 5 to 7 per cent. on coal chute tracks.

Care should be taken in establishing the alinement of sidetracks to obtain proper side clearances, 7 to 8 ft. from centers of track to any structure which is as high above the track as the car floor; the headroom should be at least 16 ft. above the top of rail. If the track runs inside of a building the cars must be so handled that the locomotive, on account of fire risks, will not enter the building.

It is customary, when sidetracks are constructed, for the railroad to enter into a "sidetrack agreement" with the shipper by which the railroad agrees to construct the sidetrack and to operate cars over it for the shippers' benefit provided he complies with the railroad's rules of operating and caring for freight cars on sidings and provided he pays for all of the sidetrack which lies beyond the railroad location line.

In some cases where a sidetrack must connect with a main track and where the logical connection is a facing point turnout which is prohibited, the arrangement shown in Fig. 14 may be adopted. A trailing switch is installed in the main track running back as a gauntlet track along the main track and then a facing switch runs out of the gauntlet into the industry. This arrangement of course has the objection of requiring two frogs and two sets of switches although only one frog and switch is crossed by the main-line traffic, and the liability of a locomotive backing over the end of the gauntlet track causing a derailment on a traffic track.

Sharp Curves.—In many yards and particularly on industry tracks very sharp curves exist. On the Jessup Branch on the Erie Railroad, for example, is an 18° main-line curve on a 2.3 per cent. grade. In the first location of many railroads sharp curves were installed which have since been reduced at great expense. In revision of railroad lines it is not infrequent that the maximum degree of curvature on main-line track is kept as low as 4°. Road engines, as a rule, are limited to 16° to 22° curves, depending upon the length of their wheel base and the number of wheels which have flanges. A good illustration of what can be accomplished by careful locomotive design is the recently constructed ten-driver locomotives on the Chicago, Burlington & Quincy, which are designed to operate on 21° curves. Some passenger coaches will not go around 20° curves unless the truck-swivel chains are disconnected, which should never be done except in an extreme case where it becomes necessary to place a coach on a very sharply curved track for some special purpose.

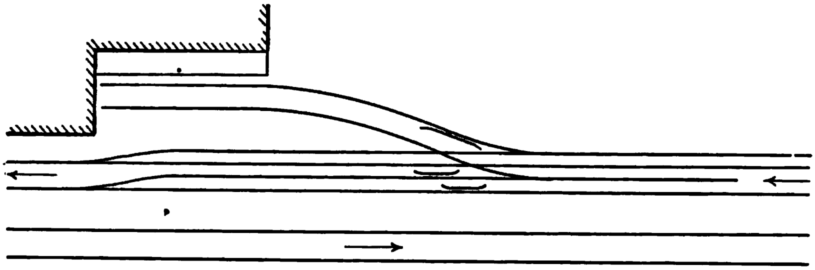

FIG. 14.—Gauntlet track arrangement to avoid facing point turnout.

A four-wheel switching engine will, as a rule, go safely around a curve of 75 ft. radius, and six-wheel switching engines around curves of 90 ft. to 150 ft. radius, depending upon their design. A single box car can be pulled around a curve of 50 ft. radius. In fact, two box cars can be pulled around curves of 80 to 100 ft. radius if a specially long link coupler is used between the cars and between the tender and the locomotive. On a radius of about 140 ft. the corners of cars are liable to strike if the equipment is the ordinary M. C. B. coupler. In the terminals about New York City are several cases of tracks of 80 to 100 ft. radius.

On all specially sharp curves the gage should be properly widened, rails braced, guard rails set and curvature maintained uniform. It is advisable to lay guard rails on all curves sharper than 14°.

Following is a short table of degrees of curves and their corresponding radii given to the nearest foot, and tangent offsets to the nearest tenth of a foot.

DEGREES AND RADII OF CURVES

Degree	Radius (feet)	[1] Tangent offsets for 100-ft. chords (feet)	Degree	Radius (feet)	[1] Tangent offsets for 100-ft. chords (feet)
1	5730	0.9	22	262	19.1
2	2865	1.7	24	240	20.8
3	1910	2.6	26	222	22.5
4	1433	3.5	28	207	24.2
5	1146	4.4	30	193	25.9
6	955	5.2	35	166	30.1
7	819	6.1	40	146	34.2
8	717	7.0	45	131	38.3
9	637	7.8	50	118	42.3
10	574	8.7	55	108	46.2
11	522	9.6	60	100	50.0
12	478	10.5	65	93	53.7
13	442	11.3	70	87	57.4
14	410	12.2	75	82	60.9
15	383	13.1	80	78	64.3
16	359	13.9	85	74	67.6
17	338	14.8	90	71	70.7
18	320	15.6			
19	303	16.5			
20	288	17.4			

Yard Tracks.—The lead, body and other tracks running alongside of main tracks, especially where passenger trains are operated, should be spaced 16 ft., center to center from the main track so as to give ample space for telegraph, telephone, electric light and signal line poles, and for signal posts, water stand-pipes, mile posts, section posts, whistle posts, without encroaching upon the prescribed clearance between them and cars on the adjoining tracks.

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[1] The tangent offset here given is the perpendicular distance from the tangen, line produced to a point on the curve 100 ft. from its beginning. The tangent offset therefore, represents the amount in feet that the curve deflects from a straight line in a length of 100 ft. In any curve the distance measured perpendicular to the 100-ft. chord from the middle point of the chord to the curve is called the middle ordinate, and the middle ordinate is practically equal to tangent offset divided by 4.

Tracks running parallel to ladder tracks should be 16 ft., center to center, from the ladder tracks, so as to enable switch lights to be readily seen and men to have room in which to move while throwing switches, for giving signals and cutting cars. When conditions permit it, ladder tracks should be straight and frogs on ladders should be all of the same angle.

Under usual conditions body tracks should be spaced 12 or 13 ft., center to center, and frogs of greater angles than No. 7 frogs (8° 10′) should not be generally used. The spacing of 12 ft. for body tracks in a storage yard is satisfactory, but for receiving, departure and classification yards, 13 ft. should be obtained where practicable. A No. 7 frog requires the use of turnout curves of about 16°, over which all of the usual kinds of rolling stock can operate, whereas a No. 6 frog requires a turnout curve of about 22°, which is about the limiting curve for road engines and is too sharp a curve for some passenger coaches. It is advisable, where it can be readily obtained, to use no smaller numbered frog than a No. 8 frog in yard design and nothing with a smaller number than No. 10 for main-line connections. No. 8 frogs in yards is rapidly becoming the accepted practice.

When the body tracks make an angle with the ladder track equal to or in some cases slightly greater than the frog angle, then every body track can be connected with the ladder track without danger of the joint at the heel of the frog coming too close to the point of the following switch. If the body tracks make an angle with the ladder track of about twice the frog angle then every other body track can be connected to the ladder track and the remaining body tracks will have to be joined to the next preceding body track.

A common practice is to have every second, and occasionally every second and third body track, connected by a switch to a preceding body track instead of running directly out of the ladder. Property limitations, physical characteristics, or urgent need for all space available, sometimes compel this arrangement. It should be avoided, when possible, because the better arrangement and compactness of the switches, the unobstructed view from end to end of the ladder and the ease with which the engineman may select his track, read signals, and know his route, are advantages which may frequently justify a heavy expenditure to secure them. Furthermore, if every body track joined the ladder, the movement in and through the body tracks is much safer and more simple because a view alongside from end to end of the train may be had (provided the body tracks are straight) which permits signals to be transmitted more readily. In some cases it may be necessary to omit one or two switches from the ladder to make room for scales, a switchman's box, bridge pier or other structure, in which cases it is simply a question of whether or not the advantage of such location for the particular structure outweighs the disadvantage of breaking into the uniform alinement of switches on the ladder.

Repair tracks should have a maximum capacity of. 15 cars, spaced alternately 16 ft. and 24 ft. center to center, and should be conveniently connected to bad-order tracks.

Team tracks should be stub tracks located in pairs 12 to 13 ft. on centers; a few railroads prefer to have them constructed in clusters of three tracks. Between the outside tracks of the clusters the roadways for teaming should be at least 45 ft. from center to center of nearest tracks, and where the freight-house or a team track is on one side and a wall or fence on the other, the minimum width of roadway should be 30 ft. As a rule team tracks should not have a capacity exceeding 20 cars each, assuming 42 ft. as the overall length of a freight car, which is the modern practice.

Standard Turnouts.—The custom is universal to designate frogs by their number. The standard numbers range from about 4 to 24 progressing by half numbers. As a rule frogs of one of these standard numbers is used, but in special cases a frog of a special number, such as No. 7.32, may be required to fit a particular situation.

The number of a frog is the ratio of its length divided by the spread between gage lines at the heel, the length being measured from the theoretical point of the frog, where the gage lines cross each other. The actual point of frog is blunt and in some frogs is several inches from the theoretical point. The approximate position of the theoretical point of frog can be found by stretching two strings along the gage lines of the frog and noting their point of intersection. If the distance is measured in feet from that theoretical point of frog to the place where the gage lines are just one foot apart, then that distance gives the number of the frog directly. A better, more practical and more accurate way of determining the number of a frog in place is to divide the total length of frog by the sum of the two distances between gage lines at each end of the frog, all dimensions having been measured in the same unit.

In constructing a turnout the frog and its guard rail are the first parts laid, and these as a rule are the only parts of the actual turnout defined by the engineer's stakes. The details of the portion from the frog toward the switch point are all given on standard turnout sheets which every railroad prepares and which vary as regards the distance from the frog point to the switch point (called the turnout *lead*), the length of switch rail, the spread at the heel of the switch, the tie spacing and many other minor details. The track foreman, however, follows the standard for that particular frog number and for that particular style of turnout.

A No. 8 spring frog has the same angle as a No. 8 rigid frog, likewise a No. 8 frog on a standard gage railroad has the same angle as a No. 8

on a narrow gage or industrial track. The number therefore defines the angle that the outer rail will make with the inner one where they cross each other. But with a No. 8 frog the turnout lead will be different for different lengths of frog, of switch rail, spread at heel of switch, etc.; and the spread at the heel, for example, will depend upon the weight of rail used on different divisions of the railroad, for yard tracks, and for main-line tracks. So that a No. 8 turnout on any given railroad does not define the entire turnout from switch to frog; there may be three or four standard No. 8 turnouts on one railroad each one suitable for a certain class of construction.

Every modern turnout is composed of a pair of split switch rails, *AA,′* Fig. 15 which in many instances are half a rail length 15 ft. or 16.5 ft. long. The switch rails are joined by splices to the rigidly spiked stock rails at *E* and *H*, both switch rails swing together about *E* and *H* as pivots, at *B* the switch rail forms a flat angle or wedge which forces the wheel to pass around the turnout, at *C* the stock rail is kinked so as to bring it parallel to *BE* and at the gage distance away from it. The portion *EG* of the turnout is a simple circular curve tangent to the switch rail at *E* and to the frog at *G*. The frog is usually straight from *G* (its toe) to *J* (its heel). The angle which the gage line of the switch rail *BE* makes at *B* with the gage line of the main rail is called the switch angle. Neither the gage line of the switch nor of the frog are brought together to an actual point, both the switch and the frog have blunt ends, so that the theoretical lead distance and the actual lead distance are different in amount. The trackman is interested in the actual lead distance which, together with the other usual dimensions, is given in the following turnout table. This table it should be remembered, will be slightly different on different roads.

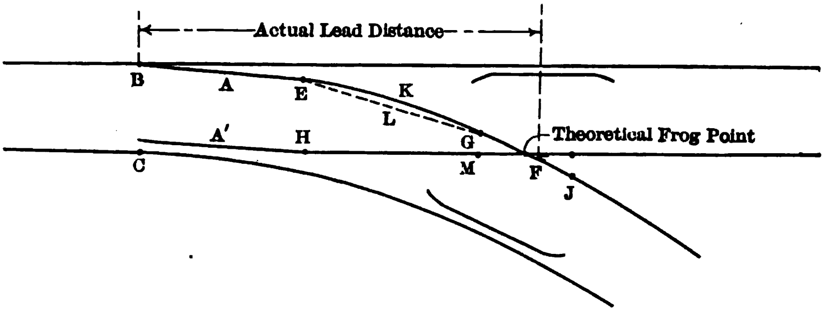


FIG. 15.—Standard turnout.

The American Maintenance of Way Association, in an attempt to standardize turnouts of a given frog number, have assigned certain arbitrary values to the lead distances which shall correspond closely to

STANDARD TURNOUTS WITH PRACTICAL LEADS

No. of frog	Frog angle	Length of switch rail ft. in.	Switch angle	Radius of center line of lead curve (ft.)	Degree of center line of lead curve	Actual lead. Actual point of switch to actual point of frog (ft.)	Use following lengths of rail for straight portion, between heel of switch point and frog H M	Use following length of rail for curved rail, between heel of switch point and frog E G
4	14° 15′ 00″	11 0	2° 36′ 19″	110.69	53° 42′ 24″	37.94	1–23.60	1–24
5	11 25 16	11 0	2 36 19	174.34	33 19 57	42.47	1–27.68	1–28
6	9 31 38	11 0	2 36 19	265.39	21 43 04	47.98	1–32.73	1–33
7	8 10 16	16 6	1 44 11	362.08	15 52 29	62.10	1–13.89&1–27	1–14.11&1–27
8	7 09 10	16 6	1 44 11	487.48	11 46 27	67.98	1–16.40&1–30	1–16.60&1–30
9	6 21 35	16 6	1 44 11	605.18	9 28 42	72.28	1–16.41&1–33	1–16.59&1–33
9½	6 01 32	16 6	1 44 11	695.45	8 14 45	75.71	1–25.82&1–27	1–26 1–27
10	5 43 29	16 6	1 44 11	790.25	7 15 18	77.93	1–27 1–28	1–27.17&1–28
11	5 12 18	22 0	1 18 08	922.65	6 12 47	94.31	1–32.85&1–33	2–33
13	4 46 19	22 0	1 18 08	1098.73	5 12 59	100.80	1–23.88&2–24	3–24
15	3 49 06	33 0	0 52 05	1744.38	3 17 01	133.28	2–33 1–25.9	2–33&1–26
16	3 34 47	33 0	0 52 05	1993.24	2 52 59	137.57	1–29.90&2–33	1–30&2–33
18	3 10 56	33 0	0 52 05	2546.31	2 14 31	146.51	1–25.93&3–26	4–26
20	2 51 51	33 0	0 52 05	3257.26	1 45 32	157.42	1–26.92&2–27&1–33	3–27&1–33
24	2 23 13	33 0	0 52 05	4886.16	1 10 21	177.22	1–32.89&3–33	4–33

the computed leads but which shall require little cutting and waste of rails. This is partially accomplished by using short standard lengths of rail which are always kept in stock, such as 18 ft., 24 ft., 27 ft. and 30 ft. lengths. The Railway Maintenance of Way Table of Turnouts with Practical Leads is given on page 47.

In passing around a turnout from the switch toward the frog, as soon as the frog is reached, the connecting track may be run either straight by extending the side of the frog or it can proceed by a curve of any degree provided the curve is tangent to the frog.

If the body tracks of the yard are straight and the ladder is straight then, with the ordinary track spacing used in yards, every body track can be connected to any ladder track which makes an angle with the body track equal to the frog angle. The following table gives distances between frog points measured along the ladder track in the case just mentioned. It will be seen by examining this table that with tracks 13 ft. on centers and No. 8 frog there is 104.40 ft. between the frog points. In the table above the lead distance of a No. 8 turnout is given as 67.98.

DISTANCE BETWEEN FROG POINTS ON LADDER TRACKS WHEN BODY TRACKS MAKE AN ANGLE WITH THE LADDER TRACK EQUAL TO THE FROG ANGLE, (IN FEET).

Frog No.	Spacing of body tracks center to center, (in feet)							Frog No.
	12	12.5	13	13.5	14	14.5	15	
4	48.75	50.78	52.81	54.84	56.87	58.91	60.94	4
5	60.60	63.12	65.65	68.17	70.70	73.22	75.75	5
6	72.50	75.52	78.54	81.56	84.58	87.60	90.62	6
7	84.43	87.95	91.47	94.98	98.50	102.02	105.54	7
8	96.37	100.39	104.40	108.42	112.44	116.45	120.47	8
9	108.33	112.85	117.36	121.87	126.39	130.90	135.41	9
10	120.30	125.31	130.33	135.34	140.35	145.36	150.38	10
11	132.28	137.79	143.30	148.81	154.32	159.83	165.34	11
12	144.25	150.26	156.27	162.28	168.29	174.30	180.31	12

If we assume the lead to be about 68 ft. this leaves 36 ft. between two adjacent frogs, part of which is taken up by the distance from frog point to the heel of the frog and the rail splice at the frog heel (usually 7 to 8 ft. in all), and the remaining distance 28 or 29 ft. is clear distance between the end of the rail splice at the frog and the point of the next switch. It is well to have about 4 ft. clear distance for this distance, which leaves in the above case about 24 ft. measured along the ladder free for some use if necessary. The way this 24 ft. is made use of is to swing the ladder so that it will make a slightly greater angle with the body tracks than the amount of the frog angle and then each body track is not straight up to the frog, but has a very short curve in it just beyond the frog as shown in the following sketch, Fig. 16.

If the tracks in this example had been 12 ft. on center the distance between frogs as given in the last table is 96.37; the lead distance plus proper clearance from frog point to the next switch point would be about 68 + 12 = 80 ft., which leaves only 16 ft. to be gained by swinging the ladder track to make a slightly greater angle with the body tracks. The advantage of laying the ladder track at the greatest possible angle with the body tracks is that body tracks can thereby be given the greatest possible length and still insure that every body track will join the ladder by its own turnout without having to join it through another body track, as is always required when the angle the ladder track makes with the body tracks is much in excess of the frog angle.

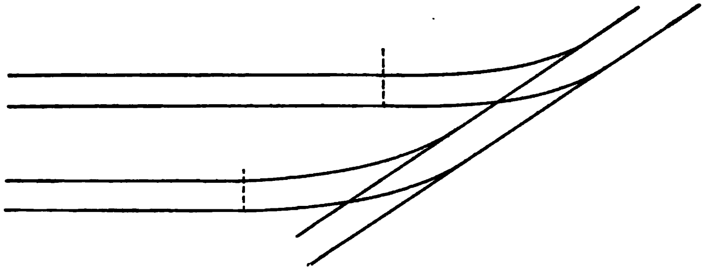


FIG. 16.

It will be observed from the Table of Standard Turnouts that the curved track of a No. 10 turnout is a 7° 15′ curve. This is the curve the rails between the switch and the frog will have if the turnout joins a straight main line track. If the main line, however, is a 3° curve, then the turnout curve will be 3° sharper (or a 10° 15′ curve) provided the turnout passes out on the inside of the main line curve, and the turnout curve will be a 4° 15′ curve if it leaves the main line on the outside of the main-line curve. If the main-line curve happened to be a 7° 15′ curve, then a No. 10 turnout on the inside of the curve would require a 14° 30′ curve for the turnout, whereas if the turnout is on the outside of the main track it will be a straight track.

The total length of a crossover between parallel tracks is dependent upon the track spacing, the numbers of the frogs and the lead distances. While all of these vary with different railroads the following general table gives some idea of the length of track required for crossovers in which the same number of frog is used at each end and where the track between the frogs is straight.

TOTAL LENGTH OF CROSSOVER

Frog No.	Track centers											
	11 ft.		12 ft.		13 ft.		14 ft.		15 ft.		16 ft.	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
6	122	6	128	6	134	6	140	6	146	6	152	6
7	142	11	149	11	156	11	163	11	170	11	177	11
8	163	4	171	4	179	4	187	4	195	4	203	4
9	183	9	192	9	201	9	210	9	219	9	228	9
10	204	2	214	2	224	2	234	2	244	2	254	2
11	224	7	235	7	246	7	257	7	268	7	279	7
12	245	0	257	0	269	0	281	0	293	0	305	0
15	306	3	321	3	336	3	351	3	366	3	381	3

Even though it does require an increase in length of track, crossovers and turnouts of large numbered frogs (small angles) are being used in main line connections to permit their operation at medium and even at high speed. Fig. 17 shows several small-angle track connections which will permit of rapid handling of traffic.

On some roads to-day No. 24 frogs and 33-ft. switch rails are used at points where a two-track and a four-track system join, and it is not uncommon to operate at the rate of 45 miles an hour through these turnouts. When the lead track to a yard joins a main line it is common to specify No. 10 to No. 12 frogs, whereas the frogs used in the yard may be No. 7 to No. 9.

Three-Throw and Slip Switches.—Split switches of good pattern should be used in all yard work; slips should be avoided as far as possible. Three-throw switches should not be used in connection with any work, where possible to avoid it. There are places where the only possible solution seems to be a three-throw switch, but it is difficult to conceive of any situation where a little mental energy will not enable the engineer to substitute a less objectionable arrangement. The saving in the operating expenses will soon overbalance the additional outlay of both energy and capital necessary to secure the result. The liability of three-throw switches to get out of order, with the close and constant supervision required, will increase the maintenance account considerably. There remains the cost of accidents resulting and interference to yard operations by such obstructions, and the vastly greater probability of derailment or other accident due to mistakes by switchmen.

There are conditions where a three-throw turnout or a tandem turnout are the only devices available. The tandem arrangement is one in which the second pair of switch points do not rest against the first pair of points, as in a three-throw switch, but they rest against the stock lead rail; that is, the first pair of switch points is 20 to 30 ft. in advance of the second pair of points. The tandem turnout does not have many of the disadvantages which the three-throw turnout has, and there are conditions where entirely separate turnouts are not possible if a flexible operating layout is to be devised, but where a reasonably good operating design can be made by the introduction of a tandem turnout.

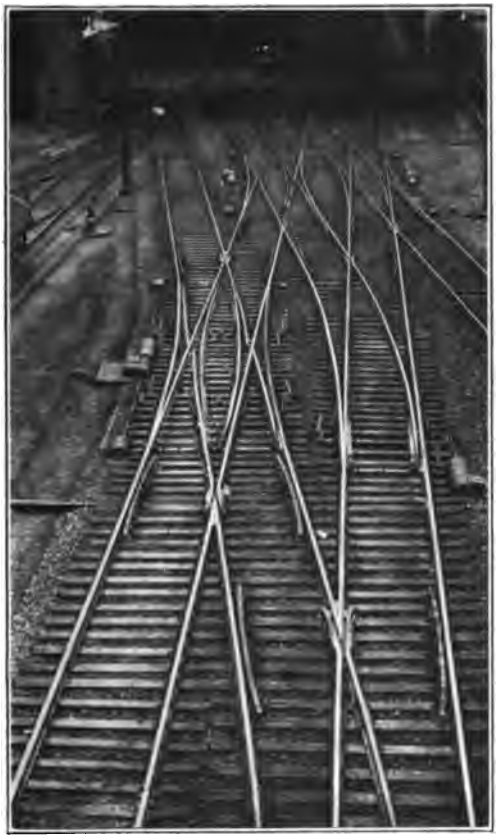


FIG. 17.—Typical easy-lead cross-overs.

It is sometimes desirable to have a yard cut in two by running a ladder across the middle of it, and in such cases it is difficult to argue against the use of the very flexible but expensive slip switches, which are expensive both in construction and maintenance. Their use enables any movement from any track in the first yard to any track in the second half, lying in line or in advance. Fig. 18 shows a track layout involving slip switches which gives great flexibility in operation. The only partial substitute for the slip-switch ladder is a double ladder and that does not give the same flexibility of operation. On the other hand, it does enable two sets of operations to be conducted without fouling each other, which is an impossibility with the single slip-switch ladder. In the double ladder, for instance, a train may be pulled out of the first yard or may "double" its cars over in or out of two, three or any number of tracks, while an engine is using the second ladder to separate cars in the second yard. Much additional ground space is required for the double ladder, which results in a curtailment of the yard capacity. This may in itself prevent the use of the double ladder where the capacity is limited.

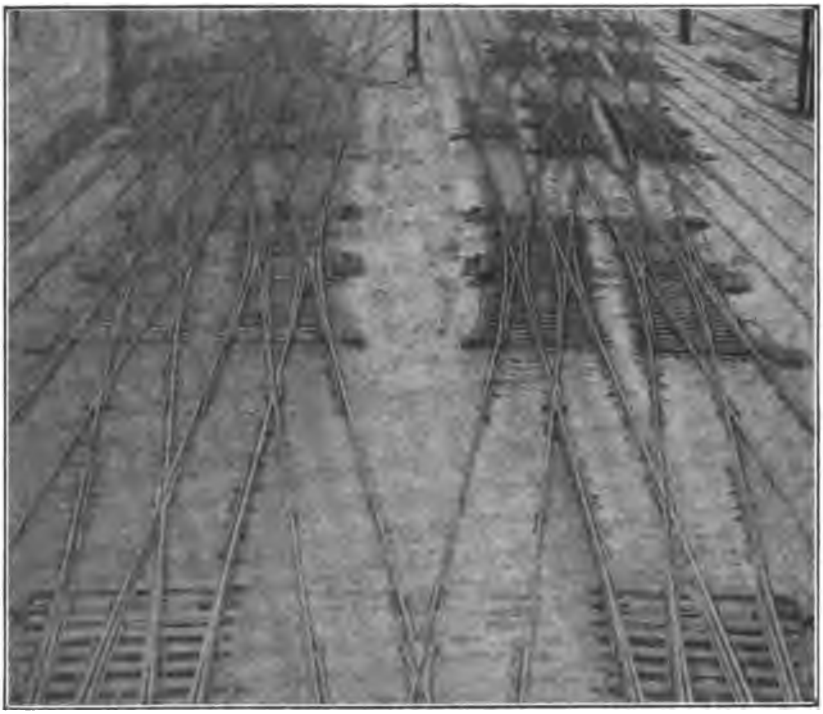


FIG. 18.—Typical use of double-slips, permitting flexibility in movements.

Crossing Frog.—On the main line, and not infrequently in yards and on industry tracks, crossing frogs have to be introduced. When the angle of the frogs in a set of crossing frogs is less than 9° (about a No. 6 frog) it is practically impossible to arrange the guard rails so as to prevent derailments and it therefore requires that such frogs shall have movable points, which adds considerably to the maintenance cost.

The practice is growing to make frog points of manganese steel and in many cases to provide for removable points. In fact, removable manganese steel switch points are now being used to some extent; and recently manganese steel has been rolled into the standard rail sections, whereas only a few years ago all rails made of this steel had to be cast, requiring extra thick webs for the rails.

Hand-Thrown Switches.—On ladders, the switch stands should be a good pattern of ground throw, one that does not offer an obstruction to a man riding on the side step of a freight car or running alongside to uncouple cars. The lever must lock itself automatically to prevent its flying over when it has been carelessly or hurriedly thrown by the switchman. To avoid accident it should throw in the direction the track runs instead of crossways or at right angles to the track. There are a good many stands that fill these requirements. A spring switch, through which a car can trail even though the switch is not set for the car, may be tolerated in some places but not on a ladder in a yard, because of the liability to accident and the seriousness of tying up the whole or most of the traffic in a busy yard while making repairs to a switch on a ladder track. While it is a subject to be discussed under the head of organization, or discipline, running through a switch should be just as carefully and thoroughly investigated and the discipline applied should be just as rigid as though it were out on the open road at a point where more serious damage could happen. That it was "in the yard," and that the switch was built for just that kind of thing, should not be permitted to influence the case at all; otherwise, the disease will certainly spread and the results may be far reaching.

There are places where switches may regularly and intentionally be run through with good operating results. Where movements inside of a yard or its adjuncts and away from the main tracks are normal, spring switches may be used in such a manner as to permit their being run through in one direction regularly. This refers to points where all movements are made over the same track and switches in the same direction. On electric roads this is usually done at passing sidings where each car regularly turns to the right (or left) and avoids the delay of having someone throw the switch. For engine movements between engine-houses and coaling plants or ash tracks, this method can frequently be applied with a saving of time for engines and men and a saving in wages for switch-tenders. A set of switches was rearranged at a large locomotive coaling plant and ash track, and by the introduction of four or five spring switches at points where they were usually kept in one position, at a cost of not exceeding $300, it was possible to dispense with four switch-tenders, two during the day and two at night, which alone involved a saving in wages of $260 a year. Furthermore, there was a considerable economy due to the possibility of more rapid locomotive movements.

Only solidly coupled switches should be used in main-line work; because they are less liable to derangement and simpler to maintain than the spring switch. After being run through they are usually rendered unfit for service and repairs must be made. It tells its own story; discipline accompanied by education does the rest. With the spring or joint connection, a switch, after being run through, may be slightly damaged and yet to the trainmen appear to be safe. If left in this condition it may cause an accident later on. The greatest objection, however, is the possibility of a small obstruction, pebble, snow or ice, or a bolt or nut falling in between the track rail and the switch rail and holding the points open while the switch lever is permitted to be seated and locked.

Switches in yards and particularly on ladders and at other important points, should be maintained in good condition. The track numbers should be painted on the targets for the convenience of the switchmen. It is good practice to assign a set of numbers to each yard. Most roads have a system of numbering trains, tracks, signals, etc., with the odd numbers in one direction and the even numbers in the other. The general practice seems to be to use odd numbers on west and southbound trains. A certain set of numbers should be set aside for numbering main tracks and passing or additional running tracks in conformity with the general practice. In a cluster of yards it may be well to start the first series, assuming it to be eastbound on an east and west road, at 10, and on the westbound at 11. If the eastbound yard contains 8 tracks, the numbers would be 10–12–14–16–18–20–22 and 24. The next yard should then start at 30 or possibly 40. This keeps the numbers in a certain series, and at the same time allows for the extension of any yard without disarranging all the numbers. All switches on ladders should be located on the side opposite the frogs. The targets with lamps should be low enough to clear the pole of a poling engine.

Power-Thrown vs. Hand-Thrown Switches.—The use of power-thrown switches, or those thrown from a central interlocking point, in connection with freight terminals, is not uncommon. Where passenger movements are involved, an interlocking of switches which connect the main-line tracks with the yard, is not only desirable but essential.

Whether or not the ladder switches of a freight classification yard should be thrown by power is a question upon which there is much to be said on both sides. The hand-thrown switches on the ground seem to possess many advantages. From the standpoint of interference with operation due to labor troubles, the arguments are pretty evenly balanced. When introducing towers and interlocking, men of higher order of skill and intelligence are employed; and with men of this type, who naturally have some sense of responsibility and duty, a sudden, unnecessary or uncalled-for cessation of work with a view to embarrassing employers to the greatest possible extent, is less likely to occur. On the other hand, switches are often manned by crippled men who have been injured in the railroad's service while in the discharge of their duties, for whom it is a matter of moral obligation and good policy to provide employment. The switch-tender who is on the ground may read the chalked number on the rear end of cars of each "cut," in summit or pole switching, and know what to "line up" for the next "cut." Movements can be made closer together because the switch-tender does not have to wait for a car to pass the clearance point before throwing the switch for the next movement. In this way much time is saved as compared with the electric systems which have to be designed so as to insure complete clearance before the next switch can be operated.

Switch tenders can do much toward keeping hand-thrown switches open. Their most important work is to keep the points open. When one switch is open, that switch may be used independently of all others and one switch snowed up does not interfere with another. There is considerably less wear and tear on hand-thrown switches. Their first cost is low and maintenance charges are light. Repairs are readily and quickly made and in case of a derailment there is usually little interference with other switches and tracks.

At Perth Amboy the Lehigh Valley has for many years operated switches on its coal docks by direct hand-power lever machines, not interlocked. These have given very satisfactory service. The switches are not far distant from the tower and the operator can readily follow the movements of cars with his eye. The system is simple and there is, therefore, little likelihood of its getting out of order. The electric lighting is ample for the men unloading coal, but work at night is only done in emergencies.

Many improvements are being made in the application of electric power to throwing switches and, doubtless, some improved system may appear which will meet entirely, or to a great extent, the objections cited. All things considered, the plan of throwing switches from a tower or central point, by direct lever movements, not interlocked, is the one that seems most practical and economical for classification yard ladders. This view is taken with the knowledge that this method permits fouling of cars, and that special arrangements must be made for advising the switch-thrower of the position of cars during night, foggy weather, snow and rain storms.

In some terminals complete systems of centrally operated switches are installed. The Altoona yard of the Pennsylvania was probably the first to install and operate power-thrown switches controlled from a central point. During many years of service this system has been operated with ease, reliability and rapidity. The power is compressed air actuated by electricity. The operator in the tower controls the switches by push buttons and when one is thrown an indicator shows when the car sent to that particular track has cleared the switch so that it can be closed again. The use of an advance "cut report" received from the conductor of each train to be classified, and of which a number of copies are made and a copy placed in the hands of each employee engaged in breaking up the trains, including the towerman, enables the operator to set up the proper route for each car without receiving any verbal directions or consulting switching signals.

The admission of air by electrically-controlled valves to the cylinder directly throws the points of the switch. It is the regular electropneumatic switch movement, without the lock cylinder and magnet. There is no locking movement. In the cabin there are two rows of push buttons, an upper and a lower one, and there are two buttons for each switch. Each button in the upper row closes its switch, and the button below it opens the switch. The ladder and tracks leading from it are divided by insulated joints into blocks embracing each turnout, and one of the point rails of each switch is insulated from the main rail. An indicator, in circuit with the insulated rails of the switch and turnout, is located on the operating board just above the set of buttons for throwing the switch. When the track is clear the indicator shows white, and when a car is in the limits of the circuit and in advance of the clearance point, or the switch has not completed its throw, the indicator shows red. A record of 133 cars switched in an hour is claimed, and an average performance of 95 cars can readily be maintained. The air pressure is 60 lbs., and the switch farthest distant from the tower is 1500 ft. away.

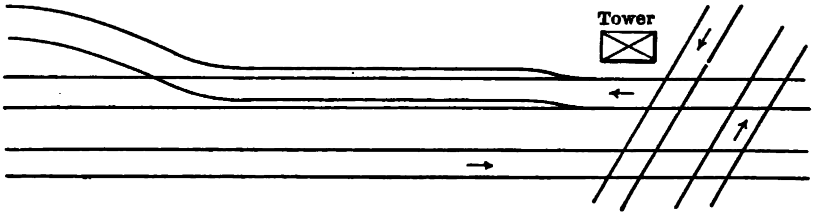


Fig. 19.—Gauntlet arrangement to shorten throw connections.

In the clearing yards near Chicago, out of a total of some 459 switches, 120 along the ladder of the classification tracks are operated by electropneumatic cylinders. These are built on substantially the same plan as those at Altoona, the central or lock magnet being omitted. The tower has 10 push-button machines, each machine controlling 12 switches. Indicators similar to those at Altoona are used.

In the case of small yards the only yard turnout operated by a towerman is the lead from the main track at one end of the yard, and it sometimes occurs that that lead is at a considerable distance from an existing tower which cannot be removed and the lead cannot for physical reasons without great expense, be extended parallel to the main track so as to join it near the tower. A method which has been used in cases of this sort is shown in Fig. 19. The lead track to the yard is extended as a gauntlet track to a point near the tower where the switch can be directly under the control of the towerman. An electric lock is introduced which prevents the towerman from clearing the signals until a train has gotten into the siding far enough to clear the main track.

Clearing Snow in Yards.—In places where there is much snow the hand-switch has a decided advantage. It requires an army of men to keep an interlocking plant in operation during a driving sleet or snow storm, because there are so many parts of the switches, locks, rods, detector bars, signals and their connections, and every part must be kept open for movement to enable any switch to be used.

An experiment was tried on the New York, New Haven and Hartford at Providence, R. I., which was successful in keeping switches and movable frogs clear during a snow storm. An engine was equipped with two 9.5 in. Westinghouse pumps, two reservoirs with a capacity of 52,000 cu. in. and a line of hose 75 ft. long and 3/8 in. inside diameter. The opening at the end of the hose was of the same size. An engine crew and four or five men with this apparatus could reach four or five tracks on either side of the engine. On the morning of January 9, 1906, with 4 or 5 in. of snow, a test was made and a complete set of double slips was blown out in 4.5 minutes. The pressure fell from an initial pressure of about 90 lb. to 70 lb., but was readily maintained at from 70 to 75 lb. The engine was again tried in four or five inches of snow a few days later with equally satisfactory results. It would make little difference if the depth of snow was four of five times as great. It is, of course, necessary to load up and haul away the snow, but the first and main object is to get the interlocking plant in operation quickly, and this it accomplishes, doing the work of from 100 to 150 men. It is difficult, if not impossible, to get that number of men out and to work during the night in less than four or five hours, while an engine and crew can be gotten out in a few minutes.

The use of hydro-carbon for fighting snow is also advocated where it is available. It was very thoroughly tried out at the South Terminal passenger station at Boston during the severe snow storms of January 25 and February 5, 1907, and its use has since been continued. On January 25 there was a fall of 10 in.; on February 4 and 5, 15 to 18 in. fell, with several inches more added by snow blown from the roofs of the 13.5 acres of buildings comprising the terminal. The February storm commenced at 10:30 p. m. on the 4th, continuing about 24 hours, the heaviest part of the snow falling between midnight and 6 a. m. of the 5th, while a blizzard raged, the wind velocity reaching 40 miles per hour and the thermometer dropping to 6 above zero. The snow drifted badly and packed in around the switch points, detector-bars and other interlocking apparatus. Not a minute's delay occurred to traffic because of the storm, although a few of the switches could not be thrown promptly because water from engines or cars fell on detector-bars and froze, causing them to stick for a few minutes at a time. The hydro-carbon was handled by the regular track gang of 33 men and the interlocking gang of six men, no extra men being employed. It was handled in safety distributing cans, capacity 2.5 gallons each, a lighted stream being sprayed to points where desired. Snow and ice in or about switches and interlocking apparatus is thus quickly melted. The height of the blaze is from 1 to 3 in. above top of rail. A switch can be thawed out in from 3 to 5 minutes. It does not injure ties, it is claimed that it acts as a preservative, and the heat applied to rails is not injurious. This South Terminal interlocking plant covers about 15 acres and contains 29 double slips, 43 single slips and some 500 ordinary switches. The cost for hydro-carbon used in these two storms was between $50 and $75; the cost of extra labor used in previous storms would range from $800 to $1000 and at least 150 additional men would have been required. Permission was given by the underwriters to use the hydro-carbon. It may readily be obtained at any Pintsch gas plant at a cost of about 4 cents per gallon.

Lighting Yards.—The proper lighting of yards facilitates switching and prevents pilfering from cars. Arc lights on poles not too high, set in such a position as to prevent, so far as practicable, the casting of shadows, are most satisfactory. It is particularly important that the summit of pole engine leads and the classification ladder tracks, be well lighted. Care should be exercised to avoid placing arc lights in positions where they may obscure or confuse signal lights. When lights are badly located they cause patches of bright light and moving shadows of deep blackness, intensified by contrast. There is more liability of confusion and accident under such conditions than there would be in uniform darkness, to which the men's eyes become more or less accustomed. For lighting hump or ladder tracks the lamps should be spaced 140 to 150 ft. apart and hung 28 ft. or higher above the tracks. For lighting body tracks the spacing should be such as to render cars clearly visible.

Bumping Posts.—For ordinary single-end tracks, bumpers are not necessary. It is usually better to let cars drop off ends of rails, where the ground is level and no damage can ensue, if switchmen are inclined to be careless. In many instances bumpers are abused because switchmen prefer to trust to them to stop cars instead of riding the cars and applying brakes. In passenger stations and in many passenger yards they are necessary to prevent serious accidents which may result from cars being pushed into or across spaces where persons may be injured; and because, in many instances, passenger cars cannot readily be coupled without bumpers to hold cars against the locomotive. On coal or other trestles bumpers should be erected, as well as on the ends of tracks abutting against buildings, or where persons are employed who are liable to be injured by a car running off the end of a track.

On some roads, in lieu of bumpers, a very simple re-railing device is used, made something like the inside rail guard on bridges, except that the rail comes out closer to the track rail. The diagram, Fig. 20, will convey an idea of its construction and method of operation. In some cases, wedges, or inclines, are placed at the ends of the main rails to enable a car wheel to ascend to the top of the rail after having been pushed off the end of the track. A car dropping off the end of a track so arranged, will generally pull back on again. The cost is perhaps less than half that of the best-known bumpers.

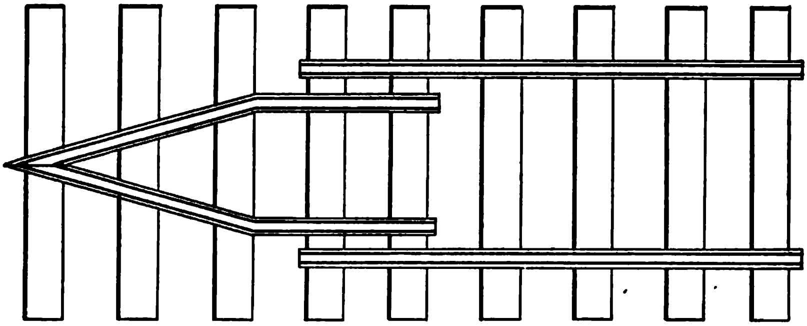


FIG. 20.—Re-railing device as substitute for bumper.

Approximate Cost of Track.—The operating officer occasionally needs to determine approximately what it would cost to extend a track, put in an additional switch or make some slight track change, possibly for the purpose of deciding whether the cost warrants the improvement. For such use the following approximate costs are given.

Where little or no grading is required and partly worn rail is used, track for sidings will cost $1 to $1.25 per linear foot, including ties. A complete turnout of similar material (80- to 85-lb. rail) will cost $175 in addition to the track. In main-line work, and with 100-lb. rail, with rigid frog, a turnout will cost $225 to $250; where a spring frog is used, about $15 more. This does not include signaling of any kind. A cross-over of ordinary construction with 70- or 80-lb. rail complete, will cost about $350 and with 100-lb. rail and spring frogs, about $500.

CHAPTER V

CLASSIFICATION YARDS

A classification yard is essentially a machine for separating trains or drafts of cars, according to prearranged plans for distributing the cars in groups according to destinations, routes, commodities, or traffic requirements, so as to accomplish their movement to tracks for these purposes. Classification or "shunting" yards may be operated under the old push-and-pull method (also called "link-and-pin" or "tail switching"); by poling; by using an artificially constructed summit or hump; and by gravity. The use of gravity alone is infrequent but it is often taken advantage of to assist hump switching, poling and the ordinary push-and-pull.

"Push-and-pull" switching is neither efficient nor economical. It is slow, expensive in operation and damaging to cars, the disadvantage increasing with the use of heavier power. In many yards, and particularly in cities or other points where a crowded condition exists, it is the only practicable method of handling. Small yards, such as freight-house, transfer, local delivery and coal yards, are invariably operated in this manner. In larger terminals it should be done away with as rapidly as possible. Among other bad features is that of moving cars in the reverse direction. In most cases many reverse movements of a car are made before it reaches its proper track in the separation, classification or storage yard.

The poling method is so far in advance of tail switching, is so susceptible to expansion, and has made such an exceptionally good record in passing cars through division, junction and tide-water terminals with a minimum of delay and of damage, that is it generally recognized as one of the best methods of separating and grouping cars. It requires an additional track for the ram or poling engine alongside the entrance leading to the yard. In some cases yards are arranged to enable the poling to be done directly from the receiving yard into the separating or classification yard. The yard engine has a pole attached to the breast beam which is so manipulated as to come in contact with the poling pocket on the rear corner of the last car in the "cut" to be started. Usually a car is built, called a poling car, equipped with four poles, two on each side; one of which works forward and the other to the rear. This car is also used for the men to ride on, and is probably a safer method of working than to use a pole directly from the engine's breast beam, by which the man guiding it can easily get caught if it should miss its mark or slip from its hold on the car. Frequently two cuts (known as a double cut) are started by placing the pole behind the last car in the first cut and then uncoupling between the two cuts after the cars are under fairly good headway, after which additional momentum is, of course, given the first cut in order to give sufficient room between that and the following cut to enable proper throwing of switches. On a level road the poling method is very hard on equipment. The cars require a heavy start and engines are rapidly worn out on account of heavy, quick starting and reversing. These conditions are aggravated during cold weather when cars run harder. In such yards it is desirable and usually necessary to continue the poling track along the ladder. In every switching yard, a descending grade running with the traffic movement is of great advantage, and it is especially desirable in a poling yard. Without an assisting grade, a poling yard handling a heavy business requires an engine to push trains being switched to the front, but when the grade is favorable the train may be started and, under regulation of brakes, continue to drop forward at uniform speed as rapidly as the poling engine can work up the cuts. A descending grade of 0.4 per cent. is valuable, but as heavy as 0.8 per cent. or even 1.0 per cent. may be used to good advantage and during winter will be none too steep. In larger poling yards it is found economical to provide an additional track for an engine to work on in running down into the separating yard and bringing back the car riders, although usually the poling engine may be used to make an occasional run when car riders are not returning fast enough. In some yards a car propelled by electricity by an overhead trolley, running on a separate track, is used to return the car riders. In one yard, where the company has an electric plant for other purposes the switch lamps are illuminated by small incandescent electric lights.

The hump or summit method consists of a natural or constructed hump, in the lead track or a part of the ladder, anywhere from 6 ft. to 10 or 15 ft. in height, with a grade on either side, ranging all the way from 0.4 to 3.0 per cent., usually tapering off on the descending side. The body tracks may be level but a light descending grade greatly facilitates the work of breaking up trains. By this method cars are pushed over the summit and after uncoupling are run down from the hump or summit by gravity. The plan has many points to commend it. Remarkable work has been done and excellent switching records made with it.

In gravity switching the grade must be sufficiently steep to start a car when the brakes are released. The yard engine is then only needed to start or feed the cars, and when low temperature or other weather conditions are such as to prevent a car from running. Gravity yards are somewhat uncommon, because it is difficult to find at the proper place, a large tract of land of the proper shape and suitable to the economical construction of such a yard.

In a paper read before the New York Railroad Club, Mr. C. L. Bardo presented the following results of an actual series of tests made by him to demonstrate the superiority of one switching method over others, having selected for each test a train of 60 cars with 50 cuts:

	Tail	Pole	Summit
Number of cars	60	60	60.
Number of cuts	50	50	50.
Crew consists of	Engineman Fireman Conductor Two trainmen	Engineman Fireman Conductor Six trainmen	Engineman Fireman. Conductor. Six trainmen.
Time consumed	2 hours	1 hour 15 min	30 minutes.
Wage expense	$2.44	$2.55	$1.02.
Distance traveled by locomotive, in feet.	24,750	24,750	6,000.

In the tail and pole methods the locomotive travel was estimated at 250 ft. in each direction for each cut made or 500 ft. for the round trip. In the summit method it was estimated at twice the length of the train to cover the return trip. Mr. Bardo comments on these tests as follows:

> "It will be noted from the table that the last, or hump method, requires one-quarter the time of the push and pull, and two-fifths of the time of the poling method. In engine service the hump method requires one-quarter the reverses of either of the other two. In the number of cars handled there is no difference between the poling or hump systems, both showing an astonishing economy over the push and pull method. In handling the train by the first-named method, assuming that the train was moved 250 ft. in each direction, for each cut, we find that the engine service is equivalent to 137 car-miles. In addition to the amount of time required to handle a train under the push and pull method, due consideration should be given to the question of expense on account of damage to lading and equipment by airbrake and reversing shocks. The figures above given were obtained from actual tests, under favorable grade conditions for the first method, and similar, though unfavorable track facilities for the other two. The results above noted indicate plainly the superiority of the hump method over either of the other two, for the classification of trains."

There is much to be said, however, in favor of pole switching and especially where it has the advantage of gravity assistance. The writer had charge of a large coal yard where 1428 loads were passed through in 10 hours and 20 minutes, or an average of 138 cars per hour. This was done with a ram and an assisting grade extending throughout the entire yard. All of these cars were passed over scales and over half of them were weighed. The scales were not automatic. The record was a remarkable one, but it is only proper to add that the conditions of weather, character of lading (coal), heavy loads, and good running cars, daylight hours, trained and reliable help all were favorable.

Diagrams of these yards are well worth careful study, not only by those interested in designing new yards or remodeling or revising existing yards, but also by those interested solely in the operation of yards. It is a mistaken idea that points in the operation of terminals may be obtained only by watching and studying actual movements; the writer has, in his own experience, derived many good lessons in operating from the study of plans of terminals built on different lines from those of which he was in charge.

One of the strongest points in favor of the pole yard or pole system of switching is the facility with which cars may be started at varying speeds in entering the separation or classification yard. This feature is particularly advantageous in colder climates where there is a greater range between the extremes of temperature. Some kinds of cars, or cars of certain construction, will run more readily than others. Those with well-supported, stiff body bolsters preventing heavy riding on side bearings, will run more rapidly or with less start, particularly through curves, as in entering ladders and in leaving the ladders and entering the body tracks. Loaded cars will run better than empty cars and heavy loads better than light ones. As the temperature drops cars run harder and in the face of a head, or what is worse, a side wind, or on snow-covered tracks, a harder push is needed because the cars will slow down to a stop in a short distance. The pole method has its advantages in such cases because the start can be made sufficiently strong to meet the adverse conditions.

It is to be said too, as one of the arguments in favor of the pole system, that the engine starting the cars works close to the front. The men in charge are therefore able to keep themselves informed as to the clearance distance of each body track and to start cars accordingly. They also have the advantage of receiving signals at short range. This advantage is particularly apparent during snow, rain, or foggy weather. It prevents damage to cars and contents.

The ease with which a change in switching methods may be made in a yard arranged for poling, is one of the arguments in favor of such a yard. The Dewitt hump yards of the New York Central near Syracuse (Figs. 21 and 22) were discontinued temporarily as hump yards during the business depression of 1907 and operated by tail-switching, because there was not sufficient business moving to continue them economically.

The hump, or summit, yard has become the standard with some railroads. Many yards which have been built within the last few years have been planned to be operated by gravity switching, aided by the

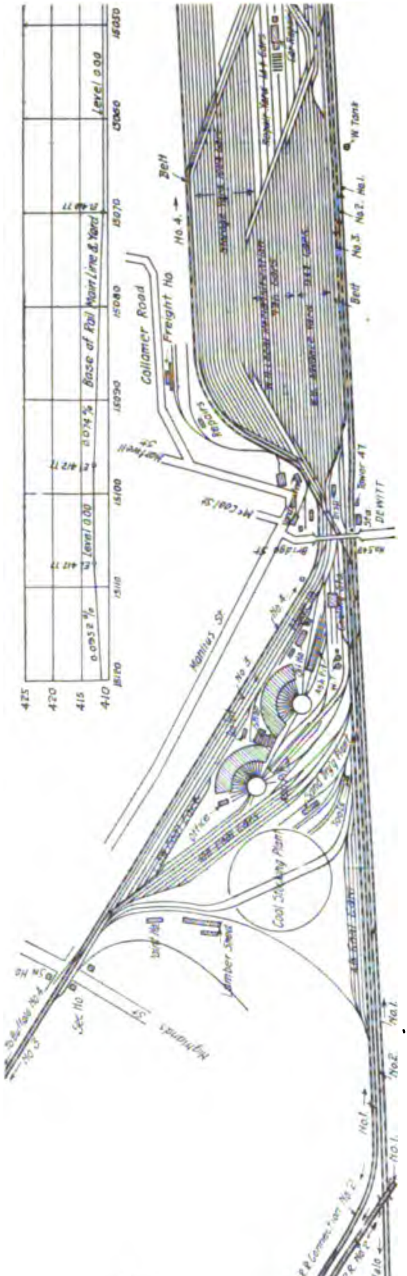


FIG. 21.—West end of DeWitt, N. Y., yards—New York Central.

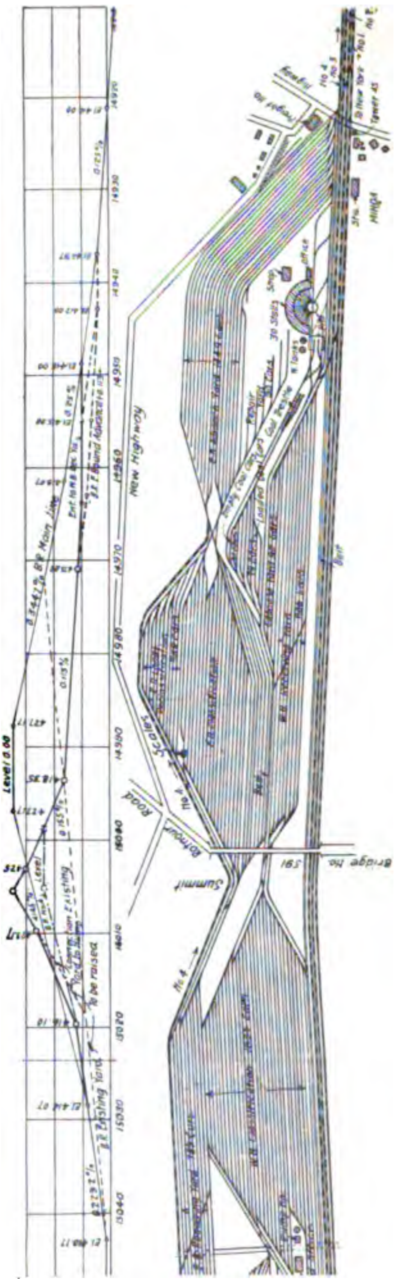


FIG. 22.—East end of DeWitt, N. Y., yards—New York Central.

summit, to give the cars their initial start after separation from the train. So important is the assistance of gravity in switching now regarded, that traffic is even reversed in direction and a cardinal principle in yard design violated in order to take advantage of a natural grade in the wrong direction. The yards of the Pennsylvania at Greenville, N. J. (Figs. 23 and 24), Logansport, Ind., and Sheridan, Pa., are examples of this practice. In other cases, the topography, instead of the traffic, has been reversed at great cost in order to have gravity assist in the proper direction. This was done in the new westward yard at Altoona on the Pennsylvania. It is now a common proceeding to construct humps on a level prairie or river bottom and make a gravity yard. Probably the largest undertaking of this kind is the yards of the Chicago Union Transfer Railway at Chicago. The company owns 3700 acres of land and the yards are more than 2.5 miles long. They contain 105 miles of track and will hold 14,000 cars.

So far as can be learned, the first summit yard in this country was constructed by the Pennsylvania Road in 1882 at Huffs Station, 2 miles south of Greenbush, Va. Before then, the idea had been applied in European yard design. Germany had a summit yard at Speldorf in 1876 and in 1888, France had one in service on the Paris, Lyons & Mediterranean Railway. There is record of a gravity yard in Dresden in 1846; in Ste. Etienne, France, in 1863; and in Edge Hill, near Liverpool, England, in 1873. (See Fig. 25.)

Statistics relating to the performance of the early summit yards in this country are rare, but there is a record of tests made by the Pennsylvania Road in its yard at Honey Pot, Pa., on the Sunbury division. On November 2, 1899, they handled 176 cars in six drafts, one car to each cut, each car being weighed as it passed over the scale, and the work was done in 63 minutes, almost three cars a minute—a remarkable performance.

In the September 30, 1904, issue of the Railway Gazette (London) the editor, Mr. W. H. Boardman, discussed the theory of summit yards as follows:

"When a train of cars, uncoupled either singly or in groups, or 'cuts,' is pushed over the summit, the leading car or cut plunges down the sharp grade at a greatly increased speed. This acceleration produces a time and space interval between each cut. It is desirable to know what conditions increase or decrease these intervals. The space interval may be disregarded if the speed at the last switching point from the lead, or ladder, is twice the speed at the summit. It is plain that if two equally easy running cars were instantaneouly set free on a uniform down grade, they would keep together—there would be no interval between them; but the change from level, or up grade to down grade allows the front car to get away at higher speed during the time that the following car moves its length on the level, and this time becomes the time interval between them.

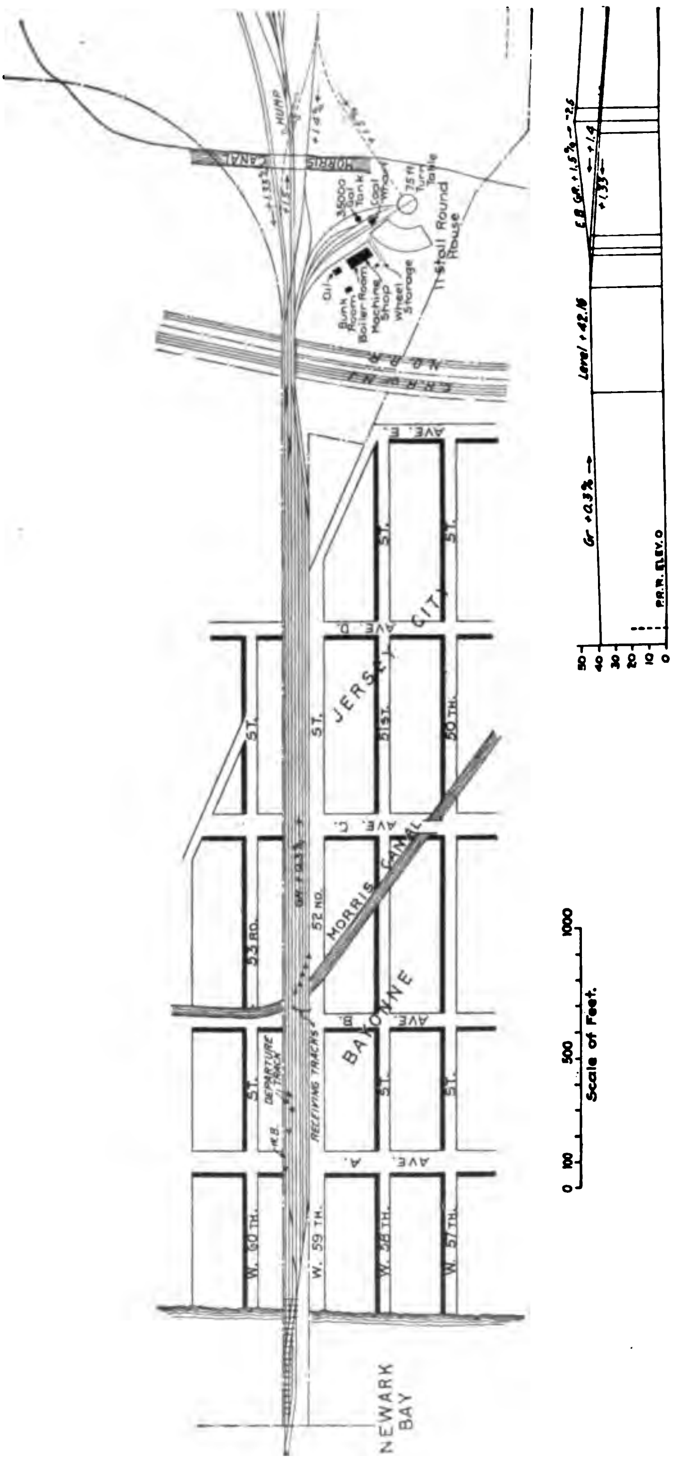


FIG. 23.—West end, Greenville, N. J., classification yard—Pennsylvania Railroad.

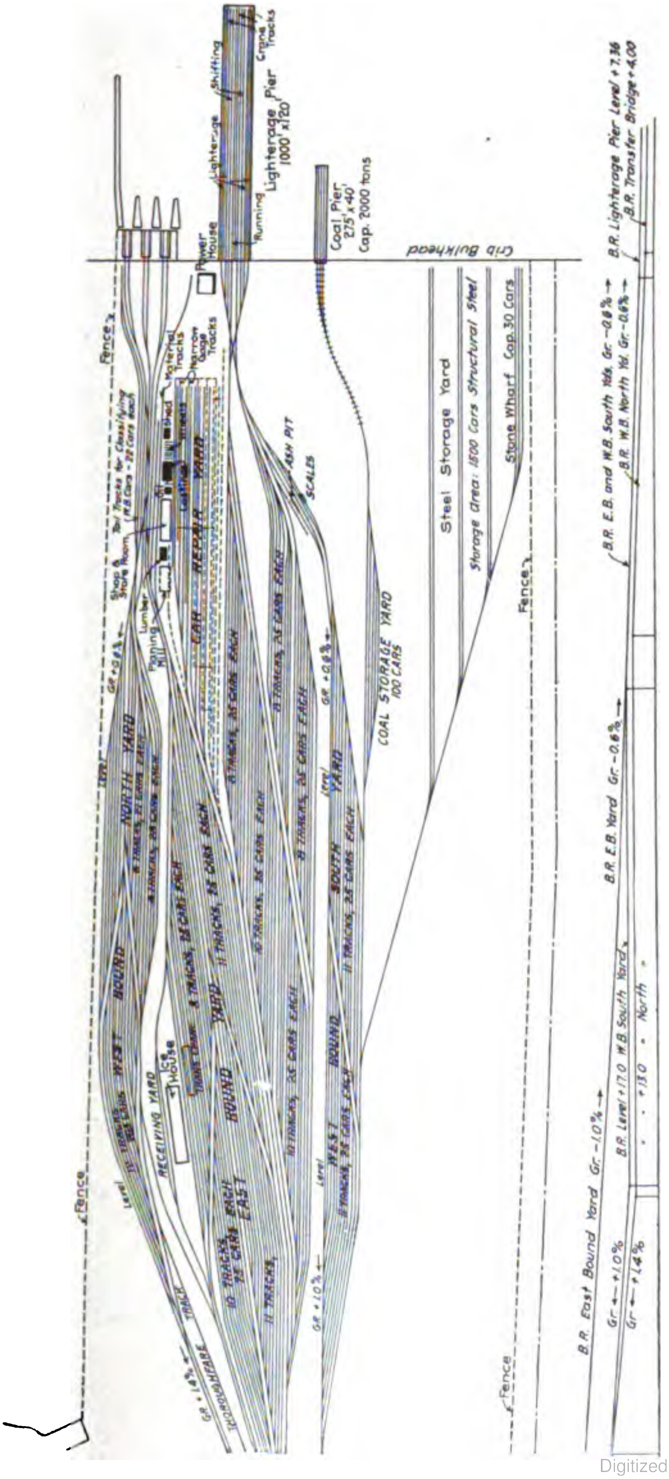


FIG. 24.—East end, classification yards at Greenville, N. J.—Pennsylvania Railroad.

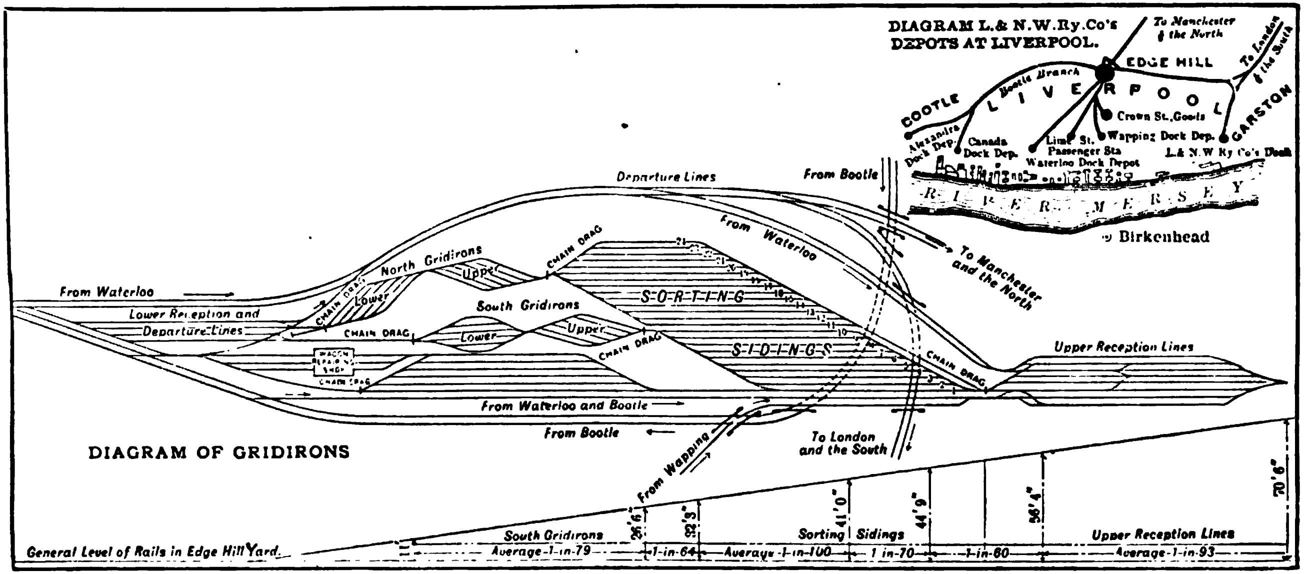


Fig. 25.—Diagrams of grid-irons, Edge Hill yards, England—London and North-Western.

"This time interval between car centers is a constant all the way down the incline and through the yard, as will appear quite clearly when the reader recalls that all the cars would run their distance from the summit to the same stopping point in the same amount of time; and that the leading car has just a car length advantage over the following car in beginning its acceleration. The length of wheel-base has nothing to do with the case. Sir George Findlay, in his valuable book, 'The Working and Management of an English Railway,' seems to have been in error on this point. If two cannon balls were sent in a guiding trough over a summit, the time interval between their centers as they rolled down the incline would vary only with their diameters, and bear no relation to positions of the points of support.

"It makes no difference (assuming equal ease in running) whether the car is poised on a pony truck, or supported by 8 wheels with either a long or short wheel-base. The elements controlling the time interval between car centers are: Over-all car length, speed in approaching the summit, and increased speed after passing over the summit. Therefore, if a train of uncoupled cars, each one 40 ft. long, approaches the summit at 1 mile per hour, each car is moving its length in 27.27 seconds, and, theoretically, this will be the time interval between the centers of the cars as they rush down the incline to the yard, where the switch points are moved to turn each car to its proper siding. (In this discussion we are considering cuts of one car each.) But it is not sufficient to compute the intervals between the centers of the cars, for the buffers will come in collision long before the centers touch each other, and meantime undesirable things are happening.

"There needs to be deducted from the interval between the centers the time taken to run a car length in the yard. For example, if the initial speed at the summit is 1 mile per hour, and if the grade from the summit is adjusted to produce a speed of 3 miles per hour in the yard, where the car would then be moving its length in 9.69 seconds, the interval between the buffers would be 27.27 seconds − 9.09 seconds = 18.18 seconds. The time interval between the buffers of any two adjoining cars is, therefore, not a constant; it is a variable on the incline and in the yard. It decreases in proportion as the cars slow down in the yard. The derived formula, which is true for any point on the incline or in the yard, is:

"Time interval between buffers = Time of car moving its length at the summit − Time of car moving its length on the ladder.

"Reversing this formula in order to find at what speed cars can be fed to the summit.

"Car-length time on the summit = Car-length time on ladder + Time interval needed for moving the points.

"If the train is to be broken up in sections of more than one car each, the same formula is applicable if the length of each section is substituted for the car length."

The ease with which the summit can be utilized to facilitate separation in large and small yards and the advantage of operating yards under this system economically, with light traffic, commend it for general use. There are many sizes of humps, or gravity mounds, with varying rates of

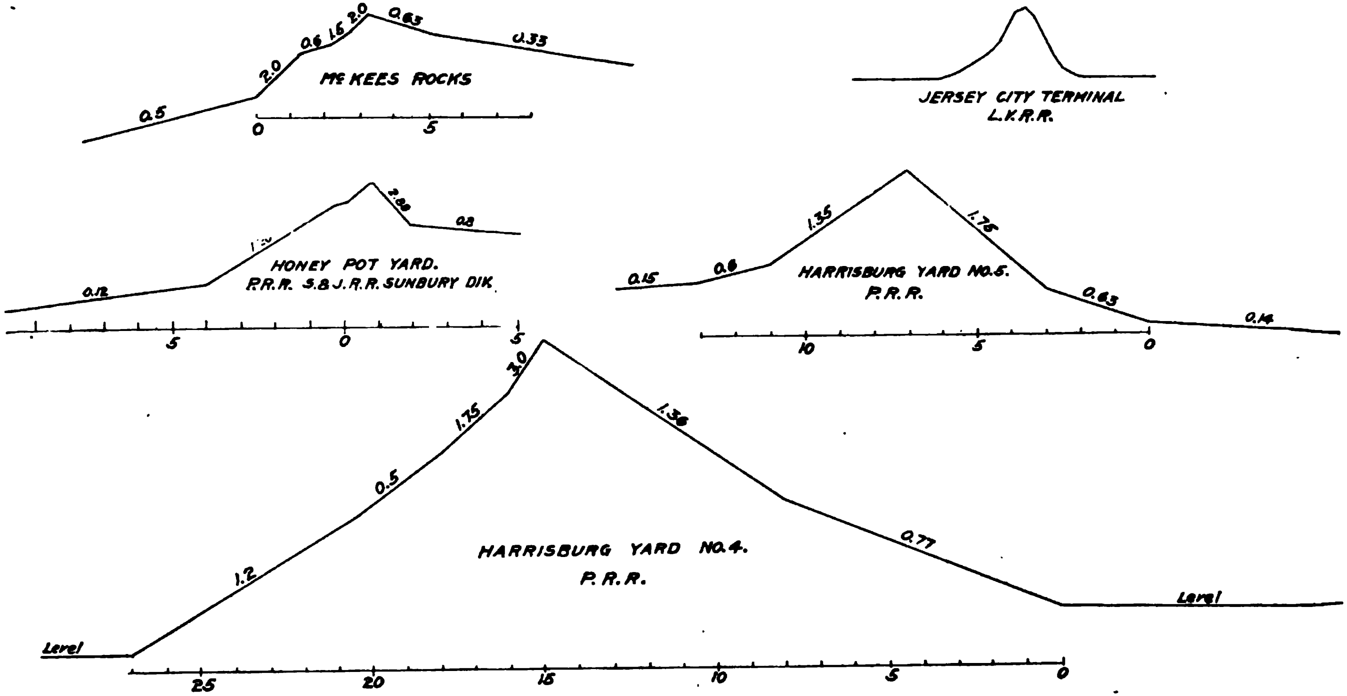


Fig. 26.—Comparative profiles of yard summits.

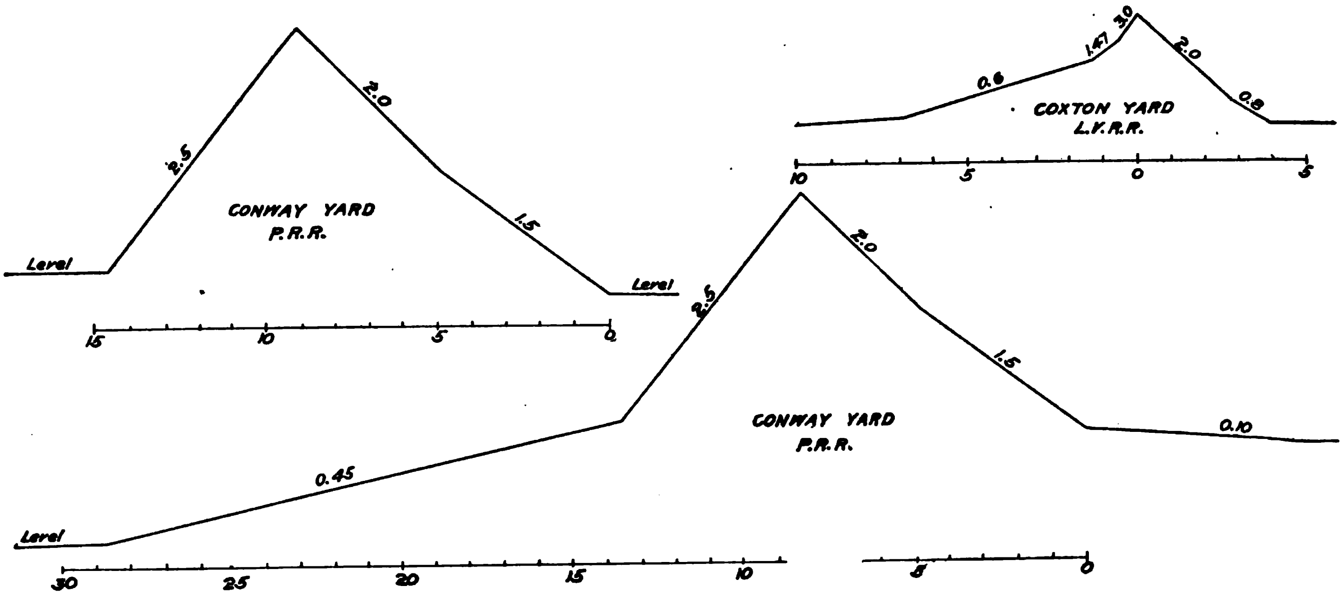


FIG. 27.—Comparative profiles of yard summits.

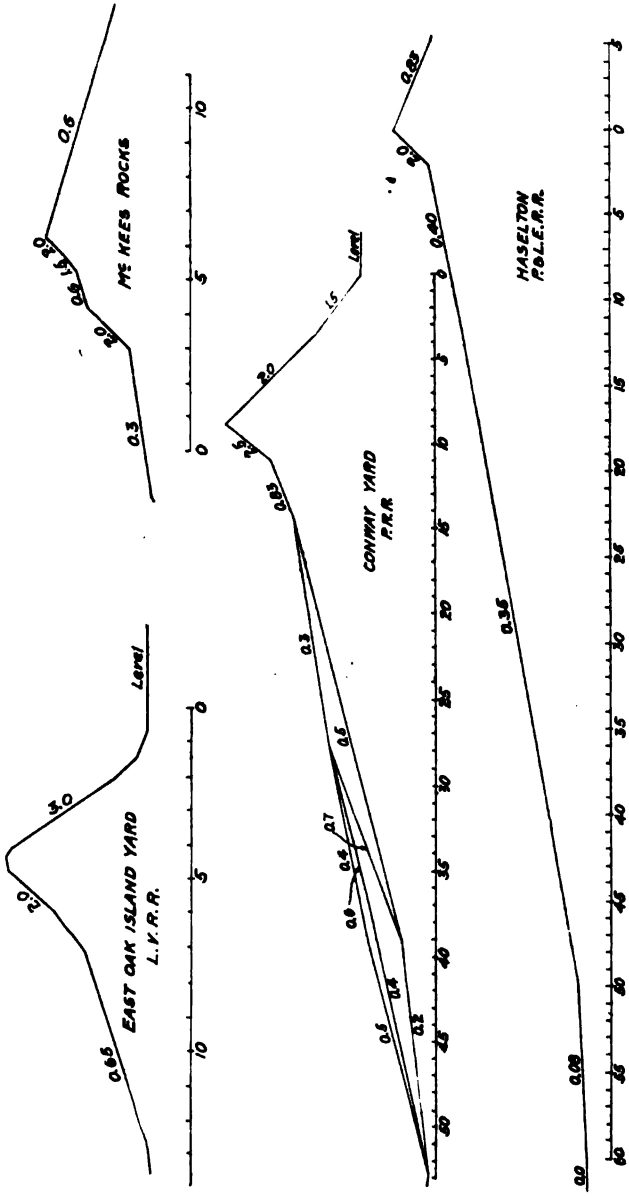


FIG. 28.—Comparative profiles of yard summits.

grade, both on the ascending as well as on the descending side, and the distances differ throughout which the latter grade continues. In the diagrams, Figs. 26, 27 and 28, the profiles of some of the principal gravity mounds are shown.

The gravity-assisting grade for a summit yard may be too long or too great. This is a most difficult problem to work out, as no hard and fast rules can be made to cover all cases. Local conditions govern, and climate is an important factor.

A separating yard with a rather heavy grade throughout would tend to increase, rather than to decrease, the expense of operation, as it would necessitate car riders accompanying each cut until stopped, thereby making a greater force of car riders necessary. A uniform, moderately heavy descending grade part way, bringing up on nearly level track, is a very good arrangement, provided the length and rate of grade can be nicely adjusted to balance the kind of cars and commodities handled, together with the temperature and wind resistance during the greater part of the year. In the Honey Pot yard of the Pennsylvania the writer has seen classifying done over the summit without car riders accompanying the cars. The freight handled, however, consisted wholly of coal. It may be remarked that the ground was well covered with coal. In a yard with a continuous descending grade of considerable fall, say 0.6 or 0.8 per cent. or greater throughout, difficulty is experienced by outgoing road engines, when they would find it necessary to back up their trains, or part them, to make couplings.

The tabulated summary of summit inclines on pages 74 and 75 gives the principal characteristics bearing upon a study of proper grades. Columns 5 and 8 may be used to assist in the comparison; the velocity at the foot of the grade is the important factor. Nothing has been added thereto for the initial velocity of the cars as they are pushed over the hump. Owing to the difference in the running of cars, as between loads and empties, gondolas loaded with coal or ore and box cars lightly loaded, and extremes of temperature, the velocities are of necessity only approximate and the effect of switches, frogs and curves cannot be considered.

Assuming rolling friction, 8 lb. per ton, which is too high for heavy cars but not excessive for empty and very light cars a grade of 0.4 per cent. is required to overcome this resistance and keep the car moving. The 0.4 per cent. grade is desirable for the classification yard, or at least a minimum of 0.3 per cent. In some cases, however, 0.2 or 0.25 have been satisfactorily used. For heavy lading, such as ore and coal, 0.5 to 1.3 per cent. grades seem preferable; while 0.9 to 1.5 may be necessary where many empty cars are moved. The first grade from the summit down is important, as it starts the cut quickly, and separates it from the following car a sufficient distance to allow the switches to be thrown between. It depends on the length of average cuts and the vertical fall required to

TABULATED SUMMARY OF HUMP OR SUMMIT GRADES

Yard	First grade from summit				Average remaining grade from 1st grade to bottom of ladders			Grade of ladders, per cent.	Grade of classified yard, per cent.	First grade from scales when any, per cent.	Distance from summit to center of scales, ft.	Standing car capacity of all yards	Character of traffic
	Grade per cent.	Fall, ft.	Horizontal length, ft.	Velocity at foot, m. p. hr.	Fall, ft.	Horizontal length, ft.	Velocity at foot of ladders, m. p. hr.						
1	2	3	4	5	6	7	8	9	10	11	12	13	
Enola.............E.	3.5	4.2	120	10.2	5	500	19.4	1.0	0.1	None.	....	10,705	Coal.
Enola.............W.	3.5	3.5	100	9.3	10	700	23.3	1.4	0.3	None.	....		Empties.
Altoona...........W.	3.9	5.8	150	12.2	13.8	1,500	27	0.92	0.29	None.	....	10,500	Empties and mdse.
Harrisburg........W.	3.6	5.4	150	11.6	14.6	1,100	25	1.5 & 1.2	0.0	None.	....	10,015	Empties and mdse.
Conway .... E.	2.5	5.5	220	11.4	15	2,800	21.9	0.5 & 0.3	0.3	0.83	250	8,967	Ore, grain and mdse.
Conway ....E.	3.0	6.3	210	12.4	13	2,000	24.3	1.0 & 0.3	0.0	1.80	350		Ore, grain and mdse.
Conway ....W.	1.8	8.6	480	13.7	8.4	1,800	19.7	0.6	0.14	1.80	220		Coal, coke and mdse.
Gr'nville (mdse)....E.	2.5	1.3	50	5.4	......	......	......	1.0	1.0	None.	......	7,842	Merchandise.
Gr'nville (coal).....E.	2.0	1.0	50	5.5	......	......	......	1.0	1.0	2.0	100		Coal.
Columbus ....E.	2.0	4.8	240	10.4	9	1,000	22.2	1.0	0.8	2.5	280	3,402	Mdse., grain and empties.
Columbus.........W.	2.5	8.8	350	14.4	7.5	750	25.6	1.0	1.0	2.5	190		Coal, coke and mdse.
Alexandria.........N.	2.5	2.5	100	7.7	11.5	900	22.6	1.0	0.35	2.0	170	3,127	Mdse. and produce.
Alexandria ....S.	2.5	2.5	100	7.7	13.5	1,100	23.7	1.0	0.30	2.0	170		
Edgemoor ....N.	1.54	0.8	50	4.0	......	......	......	1.5	....	1.5	80	2,819	
Edgemoor ....S.	1.0	0.7	70	4.0	5.25	300	14.6	1.75	0.0	1.75	80		
Logansport ....E.	2.4	3.0	125	8.4	7	800	18.7	0.5	0.04	On sum't	......	2,124	Mdse, grain and empties.
Logansport........W.	1.45	3.6	250	8.4	2	450	10.7	0.43	0.4	On sum't	......		Mdse., coke and coal.
Crestline..........W.	3.0	7.5	250	13.5	2	400	16.8	0.75	0.3	None.	....	1,784	Mdse., coke and coal.
Marysville.........E.	2.5	6.5	260	12.4	12	1,000	27.4	1.2	0.0	2.5	110	1,756	
Marysville.........W.	2.0	4.6	230	10.2	8.4	700	22.7	1.2	0.36	None.	......		

TABULATED SUMMARY OF HUMP OR SUMMIT GRADES.—*Continued*

Yard	First grade from summit				Average remaining grade from 1st grade to bottom of ladders			Grade of ladders, per cent.	Grade of classified yard, per cent.	First grade from scales when any, per cent.	Distance from summit to center of scales, ft.	Standing car capacity of all yards	Character of traffic
	Grade per cent.	Fall, ft.	Horizontal length, ft.	Velocity at foot, m. p. hr.	Fall, ft.	Horizontal length, ft.	Velocity at foot of ladders, m. p. hr.						
1	2	3	4	5	6	7	8	9	10	11	12	13	
Scully.............E.	2.5	2.5	100	7.7	13	1,000	20.5	1.3	0.5	2.5	150	1,740	Coal.
Bradford..........W.	3.0	2.4	80	7.6	3.2	700	10.6	0.45	0.45	None.	....	1,715	Coal, mdse. and empties.
Ebenezer..........N.	1.75	14.9	850	18	0.0	0	18	1.75	0.57	1.75	120	1,620	
Chicago, 55th St....E.	3.0	4.5	150	10.5	3.5	700	14.9	0.5	0.17	0.5	330	1,278	Mdse., grain & empties.
Chicago, 55th St...W.	3.0	4.5	150	10.5	3.5	700	14.9	0.5	0.5 & 0.05	0.5	400		Merchandise and coal.
Honey Pot........W.	2.0	0.8	40	4.2	5	500	13.4	1.0	0.12	1.2	90	1,194	Coal.
Sheridan...........E.	1.67	2.5	150	7.3	6	700	16.8	0.74	1.0	1.55	170	1,103	Coal.
Richmond.........W.	2.5	2.5	100	7.7	2	400	11.0	0.25	0.25	None.	....	745	Merchandise.
Linwood ....W.	3.0	3	100	8.5	4	400	16.8	1.0	0.0	On sum't	0	656	Merchandise.
Mansfield ....E.	2.5	3.2	130	8.7	4	600	15.3	0.2	0.2	1.0	250	630	Merchandise & empties
Mansfield..........W.	2.5	5	200	10.9	2.5	400	15.9	0.2	0.2	None.	......		Merchandise and coal
Chgo.Clear'g...N. & S.	2.5	5	200	10.9	19.8	2,200	28.5	0.9	0.0	None.	....	14,000	Not in use.
Youngwood........W.	1.74	1.4	80	5.4	......	......	....	1.3	0.3	2.0	120	....	Coal and coke.
Hollidaysburg........	2.0	1.0	50	5	......	......	....	2.0	0.9	2.0	100	....	Coal.
Waverley............	1.5	9	600	13.6	......	......	....	1.5	0.5	None.	....	....	
DeWitt.......E. & W.	1.0	2.5	250	6.5	......	......	....	....	....	None.	....	....	
Winnipeg.....E. & W.	3.7	11.1	300	16.7	......	......	....	....	0.0	On sum't	0	....	
•Elkhart............E.	4.3	12.9	300	18.1	......	......	....	....	0.16	....	....	....	
Elkhart...........W.	5.0	15	300	19.7	......	......	....	....	0.18	....	....	....	

In calculating columns 5 and 8, the following data were used: A single loaded car weighing 150,000 lb. = 75 tons; rolling friction = 8 lb. per ton; grade acceleration = $f = 20 \times$ rate of grade per cent. (Wellington, p. 340); grade of repose, or grade to balance resistance to motion = 0.4 per cent. (Wellington's "Railway Location," p: 335 Table 118.) No initial velocity included in column 5.

impart the initial velocity. It is generally assumed, with short cuts and no scales to be run over, that a short grade of 60 to 150 ft. in length with a 3.0 to 4.0 per cent. grade, is required; with a slope of 100 ft., a 3.5 per cent. grade. With a length of from 200 to 600 ft., a grade of from 1.2 to 3.0 per cent. will probably produce the desired velocity.

With scales on the slope, the speed over the scales must be moderate, say from 3 to 6 miles per hour. The skill of the weigher is a factor in regulating the speed over the scales. If the hump is any higher than is necessary to produce this speed, the car must be checked by the brakes. A 46-ft. scale will weigh six cars per minute at a speed of 4 miles per hour. It is possible to attain a maximum of ten cars per minute but this speed cannot long be maintained. Unless a large number of cars in each train are weighed the summit does not appear to be a good location, because the weighing is probably done with the car at rest, which would materially delay the rest of the switching. The scale grade should not exceed 2.5 per cent. for a distance of 100 ft. and perhaps 2 per cent. for a distance of 50 ft. would be better, locating the center of the scales between 90 and 150 ft. from the summit. The top of the hump should be level for about 100 ft., or the curve of the top should at least have a pretty long radius.

The hump may frequently be introduced in an existing yard, with comparatively light business, and effect a considerable saving in operating expense, and secure as well greater rapidity of car movement. This has been done in a number of instances at a cost of $2000 or $3000 and without eliminating any tracks. The saving in the enormous distance traveled by an engine with the old method of "tail switching," and the reduction in damage to equipment and contents of cars, usually make the introduction of the hump a profitable investment.

The yards of the Michigan Central at East Detroit, Mich., Fig. 29; of the Burlington at Hawthorne, Ill., Fig. 30, and of the Lehigh Valley at Packerton, Pa., Fig. 31, are successful types of poling yards. In the plans of the East Detroit and Hawthorne yards the poling tracks, ladders and body tracks are clearly shown and the operation may be easily understood. The poling track in the Packerton yard is at the extreme west end of the eastbound yard where it operates through the ladder paralleling the main tracks, as shown in Fig. 31. The ladder indicated across the main part of this yard is a double one and is used to enable its tracks to be cleared by pushing into the yard east of the ladder when necessary and to permit assistance to the classification engine in times of heavy movement.

The summit system was planned in the terminals of the Chicago Clearing Yards, of the Chicago Union Transfer Railway, near Chicago. (Figs. 32 and 33.) These terminals are the most elaborate for handling and distributing freight cars in this or any other country. They were

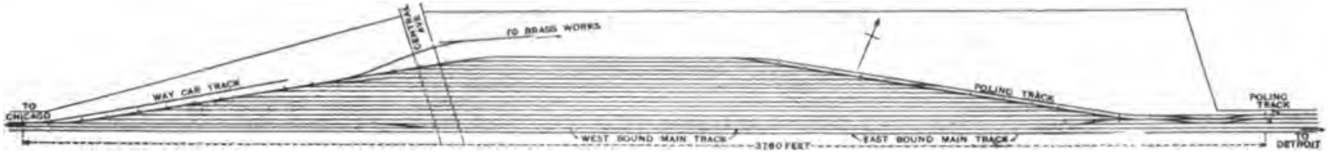


FIG. 29.—Poling yard at East Detroit, Mich.—Michigan Central.

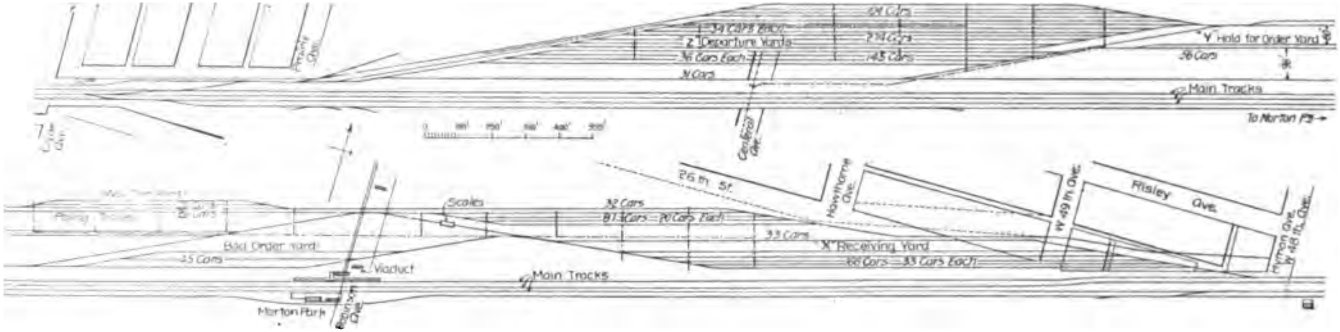


FIG. 30.—Poling yard at Hawthorne, Ill.—Chicago, Burlington and Quincy.

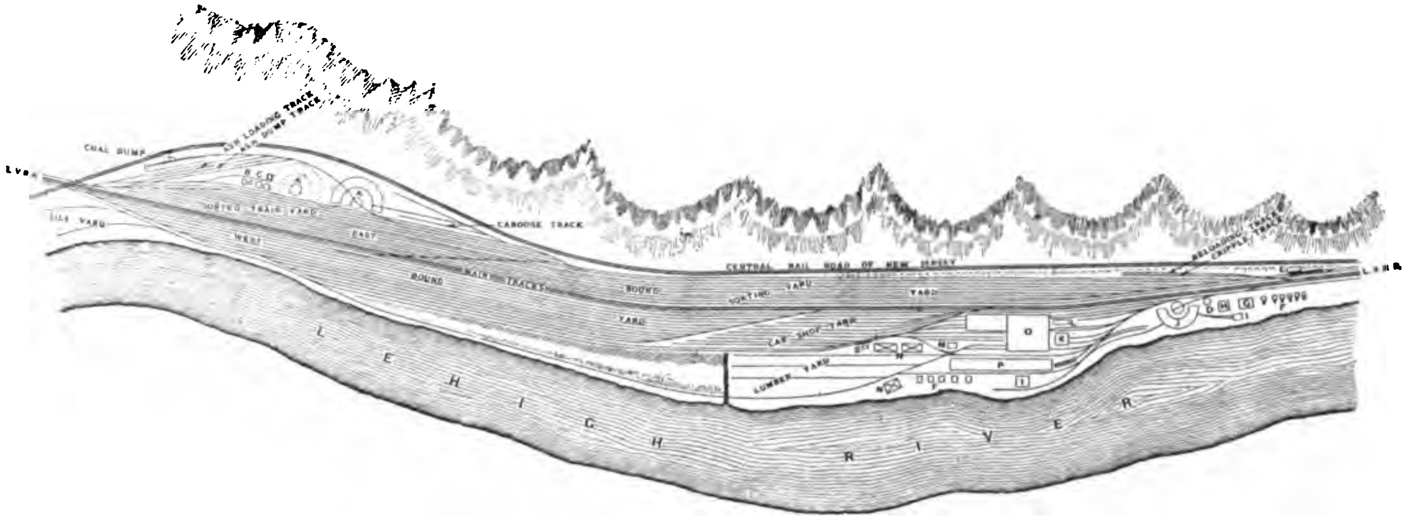


Fig. 31.—Poling yard at Packerton, Pa.—Lehigh Valley.

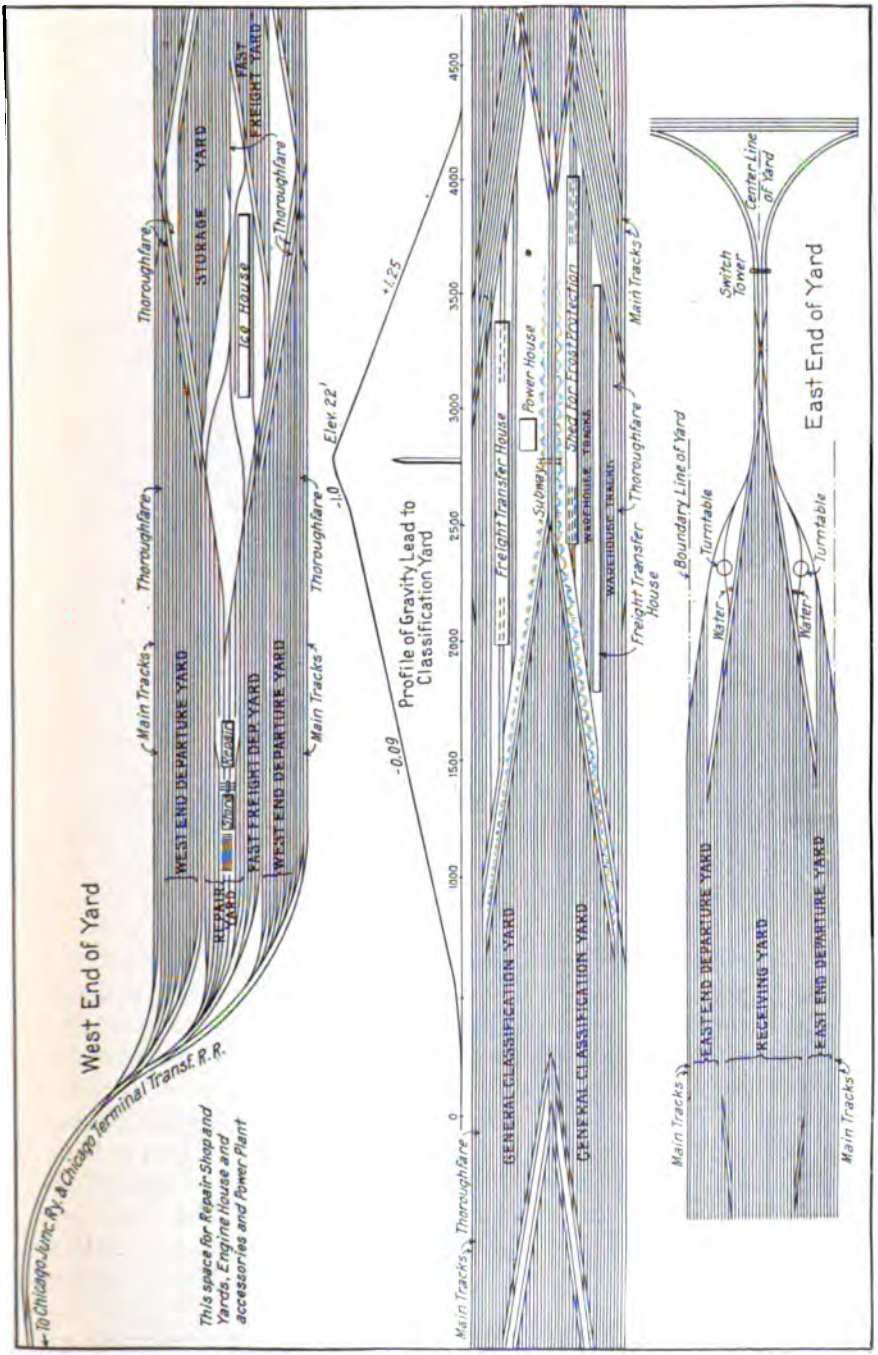


FIG. 32.—General plan—Chicago clearing yards.

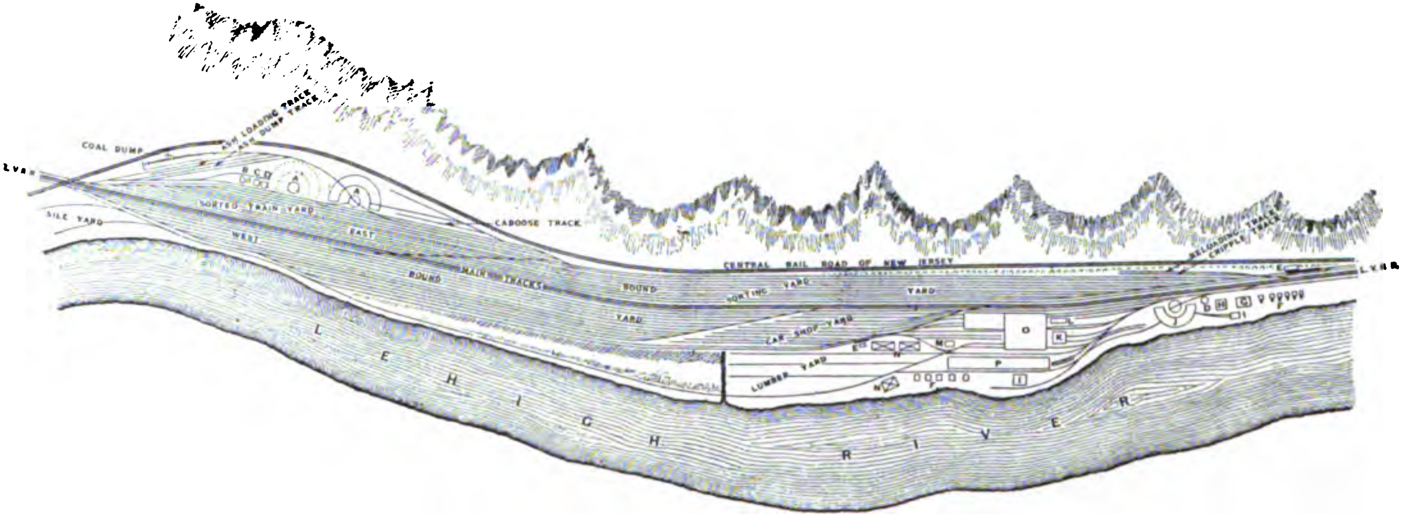


Fig. 31.—Poling yard at Packerton, Pa.—Lehigh Valley.

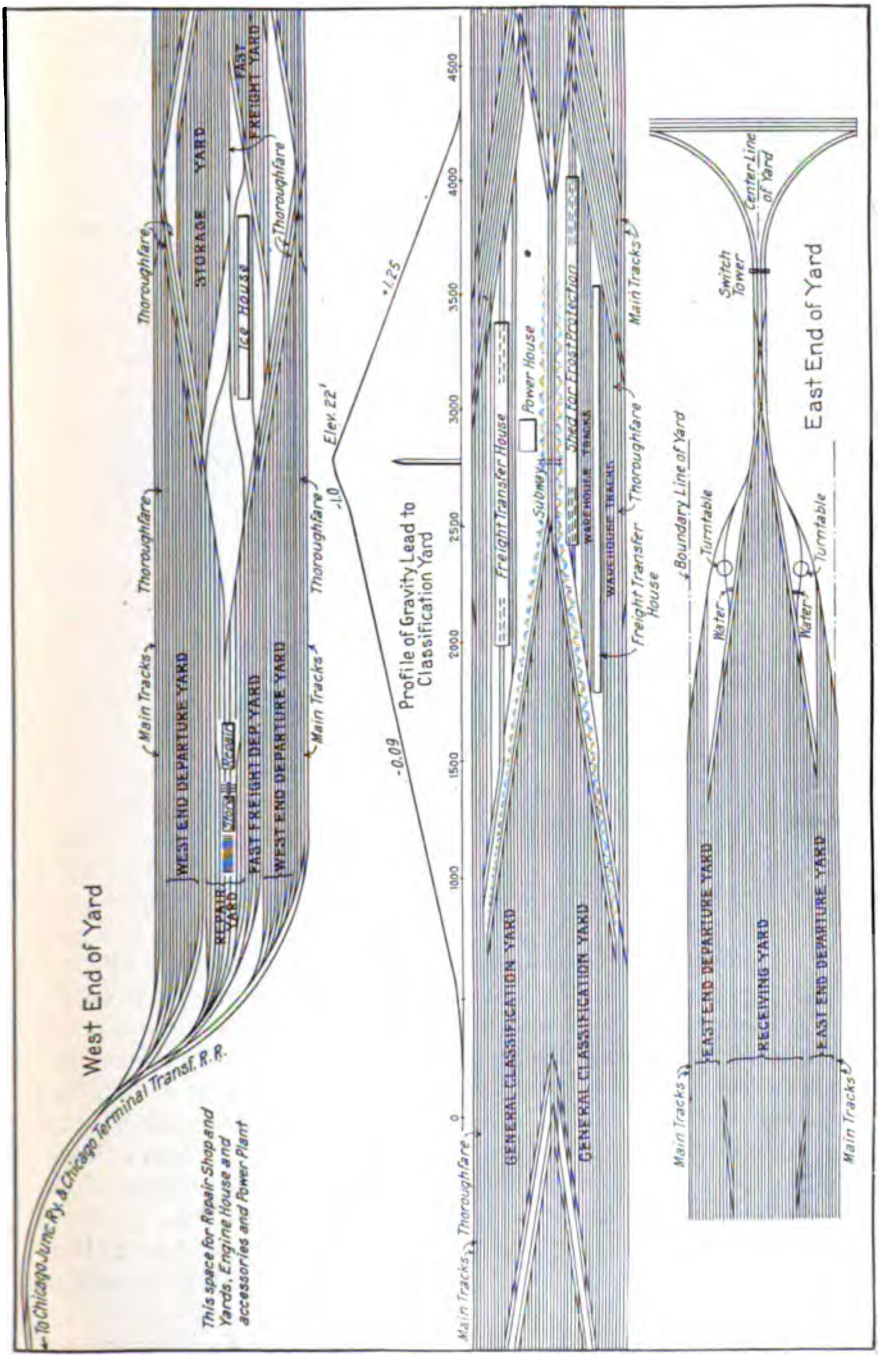


FIG. 32.—General plan—Chicago clearing yards.

designed to accomplish the receiving, separating and delivering of incoming freight and the collecting, assembling and dispatching of outgoing freight for the entire city of Chicago and the 23 railroads entering there. The summit yards are assisted by gravity in both directions, occupying a tract of land 13,000 ft. long and 670 ft. wide, and are connected with all of the belt or switching lines. The general plan, Fig. 32, consists of two sets of classification tracks, each 2400 ft. long, covering the full width of the yard; double ladders at each end leading away from an artificial summit; receiving tracks 1600 to 3200 ft. long, located north and south of the gravity summit.

A poling engine can be used when needed on account of cars stopping short by reason of heavy winds, cold weather or snow, conditions which have to be reckoned with in that territory. A light engine and car, provided for the return of the car riders, runs on the center track or on one or both of the run-around tracks on the sides of the classification track.

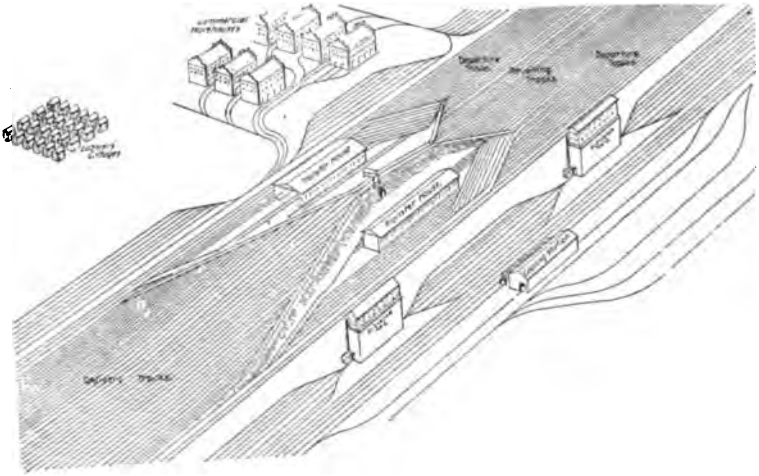


FIG. 33.—Perspective view of summit—Chicago clearing yards.

The gravity summit has 1.5 per cent. grades for a short distance each side to give the cars a quick start from the summit. This is followed by a grade of 0.9 or 1 per cent. for a distance of 1800 ft. dropping off to a grade of 0.5 per cent. for 300 ft. The foot of the gravity lead is about 400 ft. beyond the ends of the classification ladders. The apex of the summit is 22 ft. above the elevation of the level body tracks.

It was planned that the Chicago clearing yards should be able to receive and distribute 4000 cars a day in each direction, when in complete working order.

The summit yards at De Witt, N. Y., on the New York Central are shown in Figs. 21 and 22, page 64. A divisional yard was built consisting of a complete system of receiving tracks, gravity classification tracks and advance tracks in each direction.

For the eastbound movements, after trains enter the receiving tracks for that direction, the engines cut off and return by the belt track to the engine-houses. The cars are then passed over the hump into the eastbound classification yard, where they are assembled and advanced as trains into the eastbound advance yard. In connection with this eastbound movement there are caboose tracks, where the cabooses are cut off in a convenient location for coupling to westbound trains. There are also separate eastbound reclassification tracks for making up local trains. It is the intention also to develop these eastbound classification tracks with a separate system of advance tracks which will adapt the yard for both local freight and fast freight service. Car repair tracks are provided as well.

In handling the westbound movement, trains enter the westbound receiving tracks, where the engines cut off and return east by the belt track to the engine-house. The cars are passed over the hump or summit, shown on the drawing, into the classification tracks, from which they are assembled into trains and taken into the westbound advance tracks. Car repair tracks are provided and local reclassification tracks for westbound movements.

In addition to the general movement of heavy-tonnage, slow-speed freight traffic, the yard also handles fast freight trains, aggregating ten per day in each direction. The eastbound fast freight trains pull directly into the eastbound reclassification tracks, change engines and cabooses, and proceed. The westbound fast freights pull directly into the southerly tracks where cabooses and engines are changed, and the train moves on. The only switching of fast freights is the removal of any cripples which may be found, or the filling out of the trains with additional cars, which are held convenient for this purpose.

The summit grades are somewhat different from those shown on the drawing and are substantially as follows: With eastbound traffic, which consists principally of loaded cars, there is an accelerating grade of 2.5 per cent. for a distance of 150 ft., with a grade of 1 per cent. for a distance of 1200 ft. through the ladder tracks; the remainder of the classification tracks being practically level.

In the westbound yards, which handle many empty cars, and where the prevailing winds against traffic are heavier, the accelerating grade is about 4 per cent. for a distance of 150 ft. with a 1 per cent. grade for a distance of 1200 ft. The remainder of the classification tracks are on a slightly descending grade of about 0.25 per cent.

So far as practicable, every car movement is continuous toward destination; and in nearly all cases the switching is done over the hump. From 1500 to 2500 cars are handled daily in each direction. Fifty

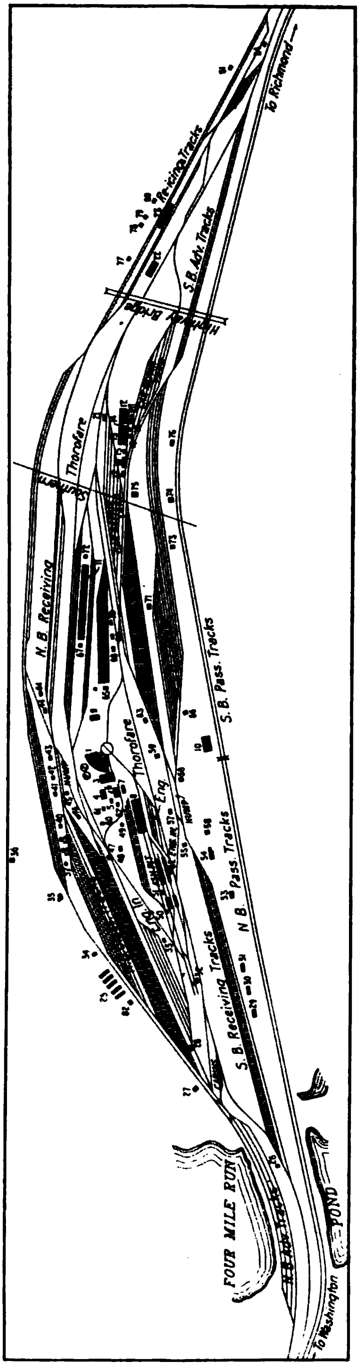


FIG. 34.—Potomac yards, near Alexandria, Va.—Washington Southern.

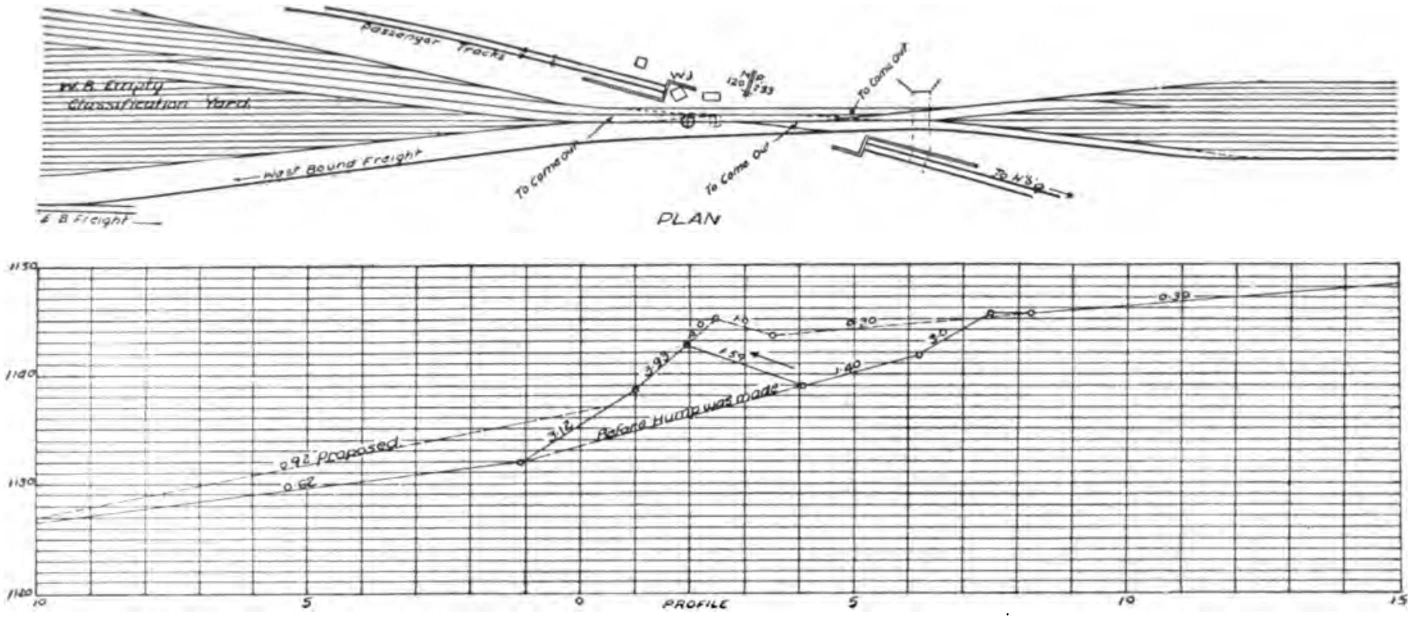


FIG. 35.—Plan and profile of summit, westbound classification yard, Altoona, Pa.—Pennsylvania Railroad.

trains may be handled each way during 24 hours, or 3500 cars each way, making a total of about 7000 cars per day.

A plan of the Washington Southern's Potomac Yards, near Alexandria, Va., is shown, Fig. 34. Electric-pneumatic non-interlocked switches are installed, to be operated from two towers; one on the apex of each hump. The tower for the southbound classification yard cares for 34 switches; the other for 38, displacing 14 ground switchmen. An average of 2200 cars per day is handled and separated into 27 "undisturbed" classifications northbound and 26 southbound. One engine works continuously on each hump. The crew for an engine consists of a conductor, a cutter, six riders and four switchmen.

In some modern summit yards the receiving yard is practically reduced to the one track on which trains proceed to and over the summit. In other words, it is expected that trains will be switched as fast as they arrive, and, barring emergencies, this is in theory what every yard should be expected to do. When this arrangement works out in practice it accomplishes the object of the yard—to provide a rapid means of collecting and classifying cars in order of destination or character of loading as they come in off the main line, and for dispatching them again.

The westbound classification yard of the Pennsylvania at Altoona is an interesting type of the use of the summit. This is shown in Fig. 35. It consists, in part, of 15 classification tracks. The westbound main freight track divides into two tracks which are carried over the scales and summit. These form the only receiving yard. The lead switches to the ladder track are 800 ft. from the summit and the cars run 2000 ft. down the body tracks. A record was made of 55 cuts, 88 cars, in one hour, and 984 cars went over the summit in 12 hours of daylight working. In 24 hours 70 trains, 1491 cars, were handled—a train about every 20 minutes.

The following tabulation (made in 1908) shows the maximum daily shifting records of the summit yards in the Altoona terminal:

Yard	Cars	Cuts	Car droppers	Cuts per car dropper
Eastbound freight classification	2,033	1,286	28	46
Eastbound coal classification	1,905	906	26	35
Total eastbound	3,992	1,925	54	36
Westbound empty classification	2,727	1,383	24	58
Westbound loaded classification	890	710	11	65
Total westbound	2,978	1,430	30	48
Total east and west	7,277	3,709	78	48

Including all the cars which pass through the several yards, some of which do not pass over the humps mentioned above, the maximum daily freight movement through Altoona approximates 10,000 cars.

An interesting experience in operating the Altoona summit occurred during the winter of 1903–4. As the nights got colder, in the fall, the cars would not run to the end of the yard. This was partly due to the low temperature but some of it was supposed to be owing to the timidity of the brakemen setting up the hand brakes too tightly at the start. As the weather became colder the trouble increased. Light cars frequently could not be made to run to the ends of the tracks, although brakes were kept off. From the summit there was a 2.55 per cent. descending grade, and from the foot, well into the yard, the grade was 0.7 per cent. A crib and rip-rap arrangement raised the summit and a grade of 4.0 per cent. was made for a distance of 200 ft., which enabled the yard to be satisfactorily operated all winter and gave the cars sufficient start to run them through the classification yard.

It has been shown that the internal resistance of trains in winter is one and one-half to two times as much as in warm weather, due largely to the difference in the journal friction at high and low temperatures. Some of the trouble at Altoona was due also, to the yard being built on made ground and with the heaving of the track due to frost, more or less resistance at the wheel tread developed, which had little or no effect in summer. The temporary summit was not continued during summer because of the liability of wrecks from runaway cars with defective handbrakes or careless brakemen. The grade of 4.0 per cent. is perhaps the steepest used, so far, with the single exception of the Lake Shore & Michigan Southern at Elkhart, Indiana, where the eastbound track has a grade of 4.3 per cent. and the westbound track a grade of 5.0 per cent. The Elkhart yard is exceptionally long, however, and with the light prevailing grade of 0.16 per cent. the steeper summit grade is not objectionable.

The writer is indebted to Mr. W. C. Cushing, Chief Engineer of Maintenance of Way, of the Pennsylvania Lines, for an interesting description of an "adjustable" mechanical hump or summit in connection with track scales at West Brownsville, Pa., used for classifying and weighing cars. This hump is installed on a firm or solid concrete foundation which does not settle when cars move over it, as do many humps located on made ground or ballast. A more prompt and uniform movement of cars over the hump is thereby accomplished. The grade in advance of the apex is about 1.5 per cent.; beyond the apex and to the scales 4.0 per cent., when the mechanical or adjustable part of the hump is elevated to the maximum height—8 in.—and 1.0 per cent. with the minimum elevation of 2.75 in. The grade over the scale is 0.8 per cent. In warm weather the minimum elevation of 2.75 in. is used and in cold weather an elevation of from 3.75 to 4.75 in. The hump is raised or lowered by means of stationary double action screw jacks and can be adjusted to the desired height in a few minutes. The practical results of this feature are satisfactory. The cost of the mechanical adjustable hump feature would add about $3000 to the total for ordinary scales.

In the Oak Island yards of the Lehigh Valley (the outlying or auxiliary yards for the tide-water terminals) a test of the possibilities of the summit switching method was made for the benefit of some visiting operating officers of the Northeastern Railway of England. Two trains, with a total of 153 cars, in 96 cuts were classified in 42 minutes, which included the time necessary to go back after the second train some distance away. There were ten classifications maintained throughout. Two cars went wrong on account of inferior hand brakes and were returned. The crew consisted of a conductor, five trainmen and one switch-tender. The time actually consumed in pushing the trains over the summit was 13 minutes for the first and 11 minutes for the second; a total of 24 minutes. The records kept show that at Oak Island in handling 253,000 cars the amount of damage done, directly chargeable to the summit grade, was less than $800. It is claimed too, that the damage was more than this prior to starting the use of the summit method, when the yards were worked under the poling method.

Available accurate statistics of the cost of switching by any method are seldom found. The hesitation on the part of operating officers in giving out any information on this subject is readily understood because of the fact that conditions vary to such an extent as to make almost any comparison on a simple cost per car statement practically worthless. So many explanations and qualifying additions must be affixed to any cost statement as to render it useless because of its obscurity, even though we assume that some uniform standard or unit has been reached on which to base the cost. The "number of cars handled" has so many meanings and is figured out in so many ways that it is not always comparable.

In the Pittsburg & Lake Erie yards at McKees Rocks the cost of handling cars over the summit was a fraction over 9 cents each. During something over 12 months, there were 253,551 cars in 123,351 cuts run over the eastbound summit at Oak Island, N. J., at a cost of 11.7 cents per car, or 22.1 cents per cut for classifying. Of this cost 55 per cent. was for train-crew wages; 45 per cent. for fuel, water and supplies.

Mr. Cushing obtained the figures of cost of working in 25 different yards at nine separate periods, in the last 10 years. When these figures include the yard labor only (yardmasters, clerks, conductors, brakemen, switchmen, enginemen, firemen, operators and watchmen) the cost per car handled for terminal yards in large cities, where there is a large distribution of cars to industries (as in Chicago), ranges from 15 to 30 cents; in intermediate yards in cities of good size with a fair amount of distribution to industries (as in Columbus, O.), from 17 to 22 cents; in intermediate yards in small towns and cities which are junction or division points, with but a minor industrial development, from 8 to 20 cents, and yards in villages without industrial development, and which are junction or division points, from 5 to 15 cents.

The manner of operating a yard, whether by gravity or other methods, does not seem to influence the cost so much as the condition of handling it; whether traffic is passing through smoothly or in a sluggish manner.

The accompanying diagrams of a yard for tidewater coal handling and storage plant, and a yard for tidewater freight delivery were prepared by Mr. C. L. Bardo, as shown in Figs. 36 and 37. The interesting feature in connection with Mr. Bardo's proposed division classification yard is the so-called central ladder. Its advantages are summarized in Chapter III, page 30.

The Pennsylvania yard at Greenville, N. J. (Figs. 23 and 24), is a recent development of an important tidewater terminal on a large scale with the hump method of classifying. The greater part of this work is on submerged land on the New Jersey shore, 3.5 miles south of the Pennsylvania Railroad passenger station at Jersey City. The established pier line lies out in New York Bay, about 1.8 miles from the shore. The water frontage is 1900 ft. and the land frontage along the present shore is 2600 ft. The distance between the pier line and the bulkhead line is over 4400 ft.; thus allowing piers to be built over four-fifths of a mile long. The area of the submerged portion is 550 acres and of this the land between the bulkhead line and the shore line amounts to 350 acres.

The Peoria & Pekin Union (Fig. 38), a terminal property within and connecting the two cities of Peoria and Pekin, Ill., and owned by six roads, is an interesting study.

During the year 1905 there was a total in-and-out movement of 570,000 cars over these terminals; and the total cars handled and switched on orders, including the above, was 1,116,000 for the year. The total days engine service for the year was 8900, making a total of 125 cars handled per engine per day. The present mileage of the Peoria & Pekin Union Railway is 93 miles, composed of 25 miles of main lines, 9 miles of side tracks on line and 59 miles of yard tracks. There is a total of 560 switches, four interlocking plants and one drawbridge in connection with all tracks.

The records show that the business through the Peoria gateway has increased about 8 per cent. each year for the past decade and that the present capacity of this property for economical handling of business should not exceed 2000 cars per day. It therefore became necessary to increase the present capacity enough to take care of the natural in-

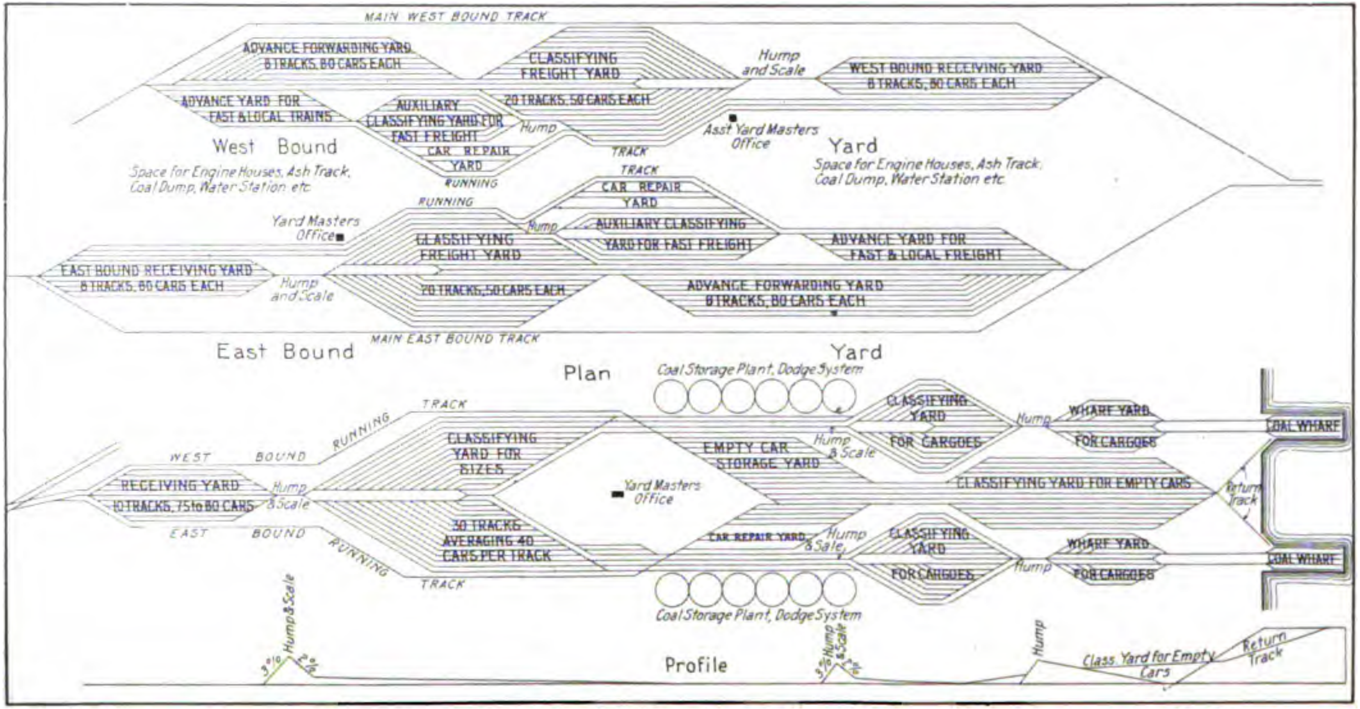

MAIN WEST BOUND TRACK
ADVANCE FORWARDING YARD 8 TRACKS, 80 CARS EACH
CLASSIFYING FREIGHT YARD
Hump and Scale
WEST BOUND RECEIVING YARD 8 TRACKS, 80 CARS EACH
ADVANCE YARD FOR FAST & LOCAL TRAINS
AUXILIARY CLASSIFYING YARD FOR FAST FREIGHT
20 TRACKS, 50 CARS EACH
Hump
CAR REPAIR YARD
TRACK
Asst Yard Masters Office
West Bound Yard
Space for Engine Houses, Ash Track, Coal Dump, Water Station etc.
Space for Engine Houses, Ash Track, Coal Dump, Water Station etc.
RUNNING
TRACK
RUNNING
CAR REPAIR YARD
Yard Masters Office
Hump
AUXILIARY CLASSIFYING YARD FOR FAST FREIGHT
CLASSIFYING FREIGHT YARD
ADVANCE YARD FOR FAST & LOCAL FREIGHT
EAST BOUND RECEIVING YARD 8 TRACKS, 80 CARS EACH
Hump and Scale
20 TRACKS, 50 CARS EACH
ADVANCE FORWARDING YARD 8 TRACKS, 80 CARS EACH
MAIN EAST BOUND TRACK
East Bound Yard
Plan
Coal Storage Plant, Dodge System
TRACK
CLASSIFYING YARD FOR CARGOES
RUNNING
Hump
WHARF YARD FOR CARGOES
COAL WHARF
WEST BOUND
CLASSIFYING YARD FOR SIZES
EMPTY CAR STORAGE YARD
Hump & Scale
CLASSIFYING YARD FOR EMPTY CARS
RECEIVING YARD 10 TRACKS, 75 to 80 CARS
Hump & Scale
Yard Masters Office
Return Track
EAST BOUND
30 TRACKS AVERAGING 40 CARS PER TRACK
CAR REPAIR YARD
Hump & Sale
CLASSIFYING YARD FOR CARGOES
WHARF YARD FOR CARGOES
COAL WHARF
RUNNING
TRACK
Hump
Coal Storage Plant, Dodge System
Hump & Scale
3%
2%
Profile
Hump & Scale
3%
1%
Hump
Class Yard for Empty Cars
Return Track

FIG. 36,—Suggested yard for tide-water coal handling and storage.

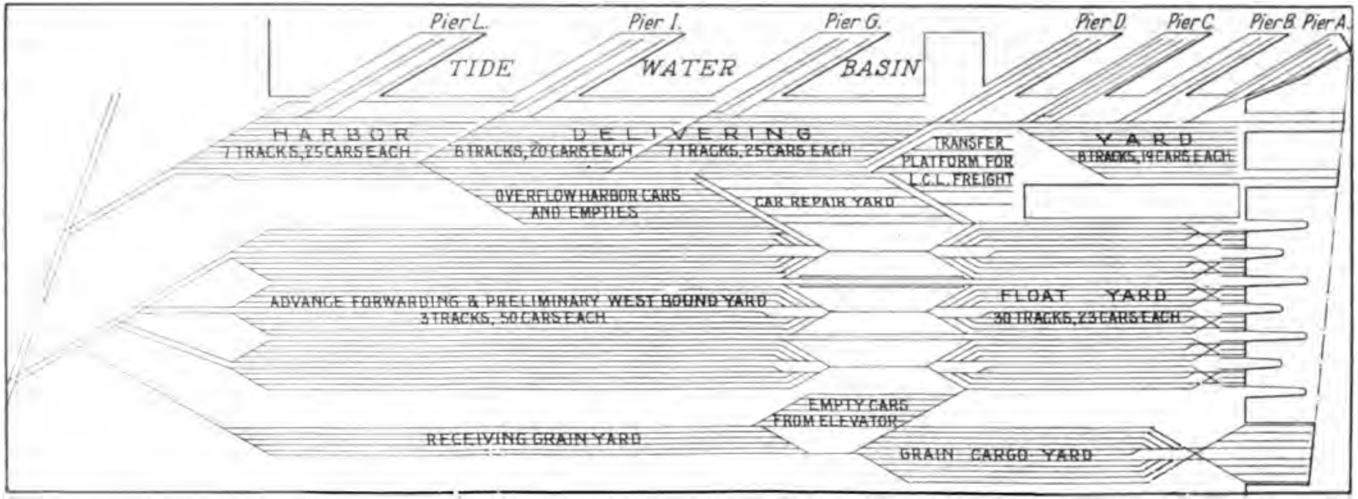


FIG. 37.—Suggested tide-water classification and freight delivery yards.

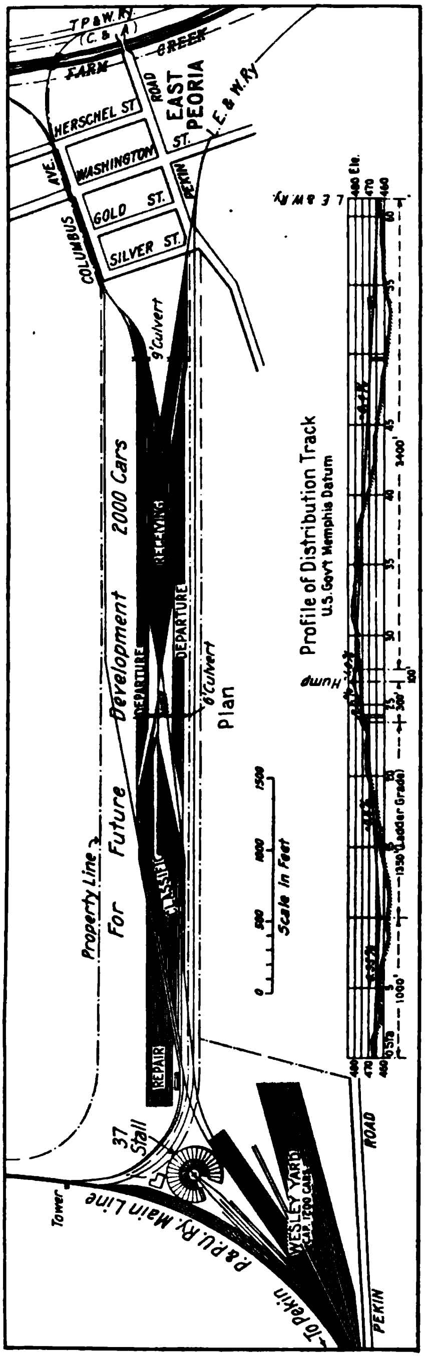


FIG. 38.—Development of terminal properties, Peoria and Pekin, Ill.—Peoria Pekin Union.

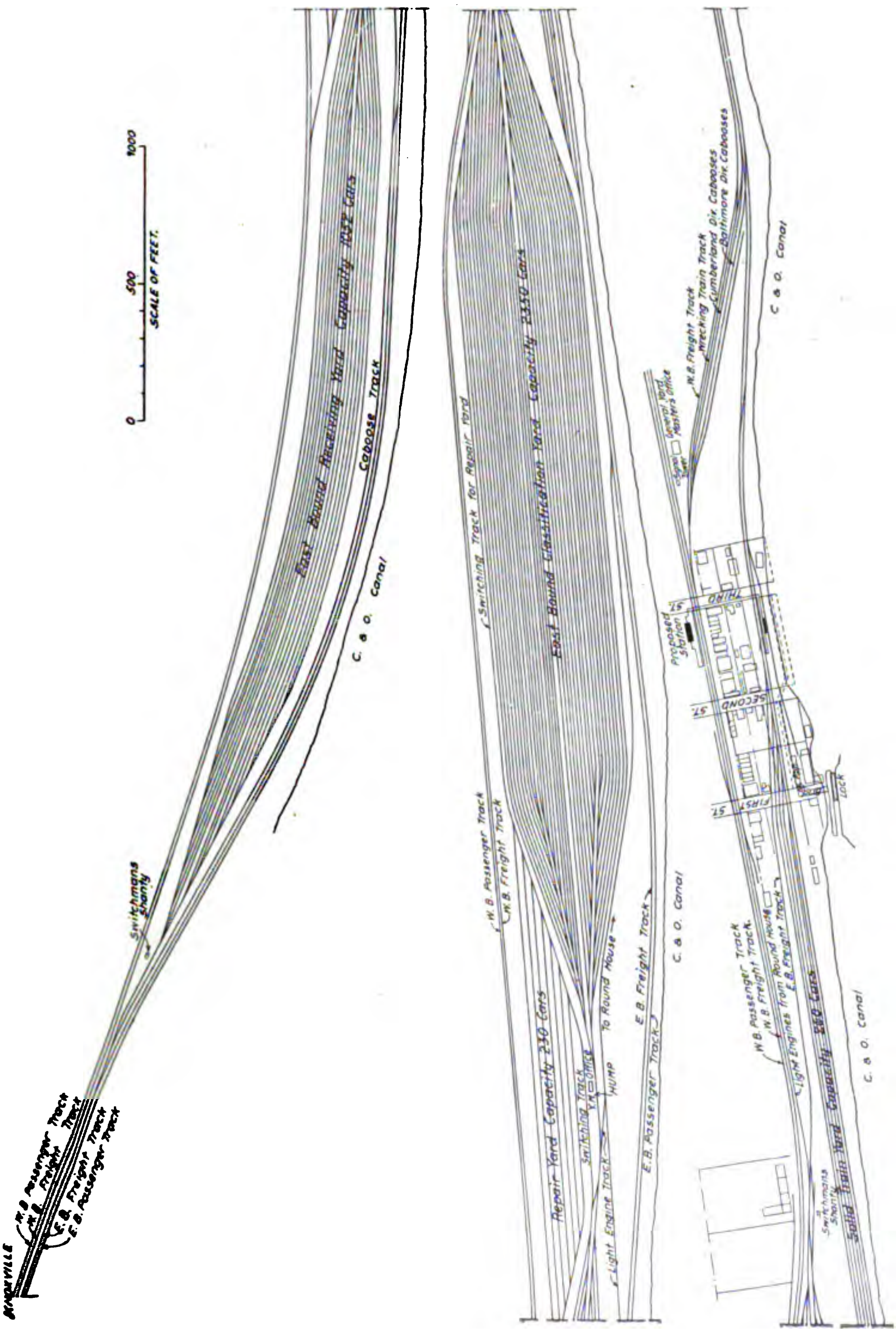


FIG. 39.—Eastbound yard system at Brunswick, Maryland—Baltimore & Ohio.

crease of business for the next decade. A new yard was accordingly decided on.

The portion of the yards north of the distribution or hump track consists of a receiving yard of seven tracks, with a capacity of from 40 to 60 cars each and a departure yard of seven tracks with a capacity of 50 cars each. A classification yard of 22 tracks with a capacity of 500 cars, lying immediately west of and connected by double ladder with the hump track, serves to accommodate the classification of both inbound yards. A 150-ton railroad track scale fitted with automatic weighing device, is conveniently located on outside track of the classification yard. All cars to be weighed pass over the scale, which is built on a 1 per cent. grade, and afterward are pulled back on the distribution track and sent over the hump to their proper place in the classification yard. The bad order cars are dropped into the north side of the classification yard and pushed through into the repair yard, which lies immediately west of the classification yard and is composed of 11 tracks, with a total capacity of 200 cars.

The tracks in general are spaced 13 ft. centers with 15 ft. centers on ladders. The repair yard tracks are spaced in pairs of 16 ft. centers and 42 ft. center to center of pairs, thus allowing room for a material or supply track between each pair of working tracks.

The drainage is taken care of by two large concrete culverts of flat top design, the tops being of I-beam and concrete construction. The location of the hump is such that it can be raised or lowered as the weather conditions demand.

A plan of the Balto. & Ohio eastbound yard at Brunswick, Md., is shown in Fig. 39. The objectionable but unavoidable curvature stands out prominently. The splendid main track separation arrangement is apparent.

The Chicago and North Western 40th Avenue yards, Chicago, are shown in Fig. 40.

This is the largest of the North Western's yards in Chicago; a little over 30 miles of track and a capacity of 5000 cars. Normally, 40th Avenue yard is used exclusively by the Wisconsin and Milwaukee divisions.

Figure 41 shows the New York Central's West Albany yards. The total trackage of the yard proper is about 73 miles, with a capacity of 6100 cars, embracing 393 switches. In addition to the yard itself there are 5.8 miles of track, serving the engine-houses, car shops, erecting and boiler shops, transfer tables—an additional capacity of 311 cars. The yard labors under the disadvantage of being split into two yards by the eastbound main-line freight tracks, although no attempt is made to keep them clear from end to end.

The plans in Fig. 42 are those of the Big Four's yards at Lyons, Ill.

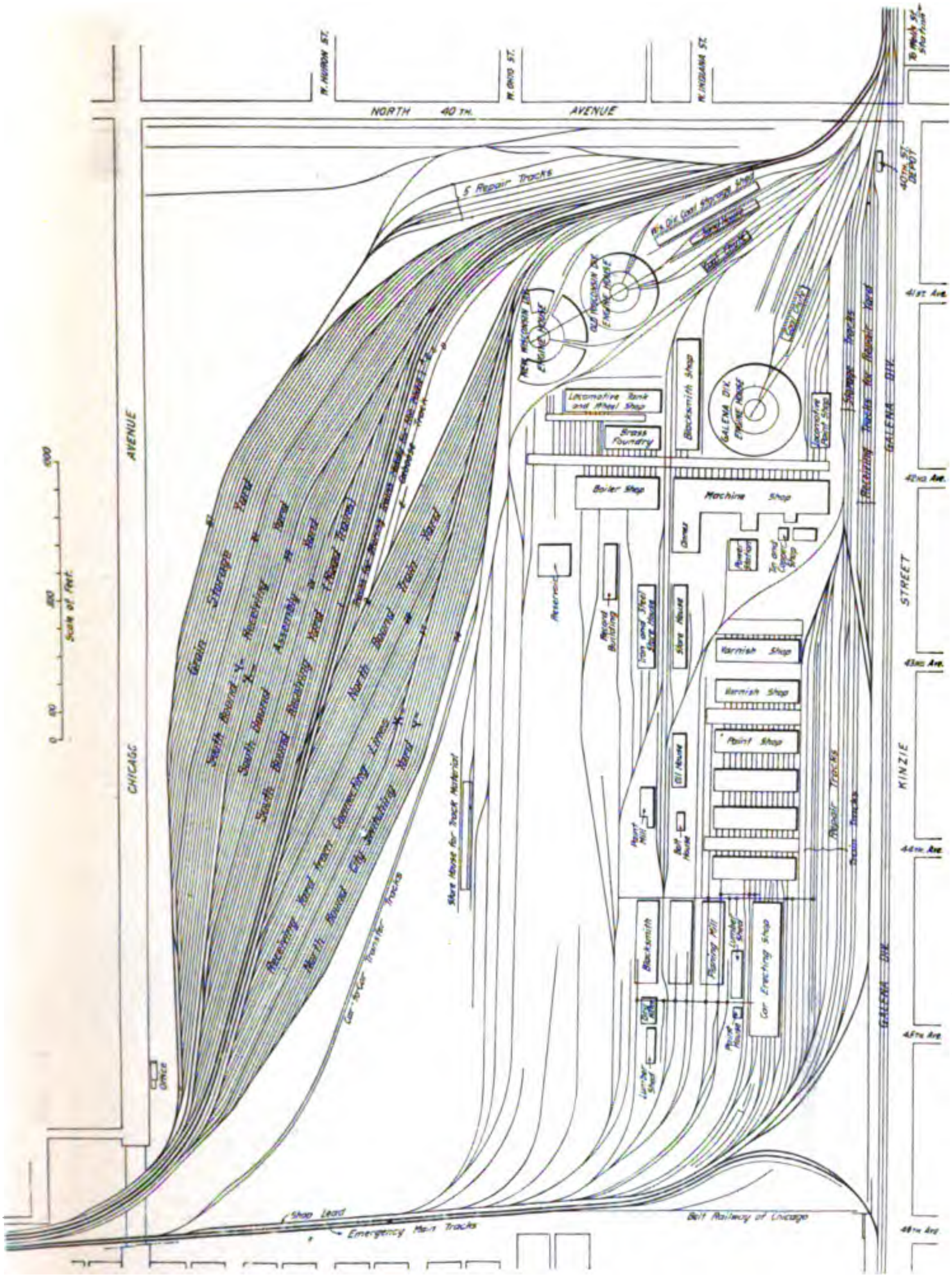


FIG. 40.—Fortieth Avenue yard, Chicago—Chicago and North-Western.

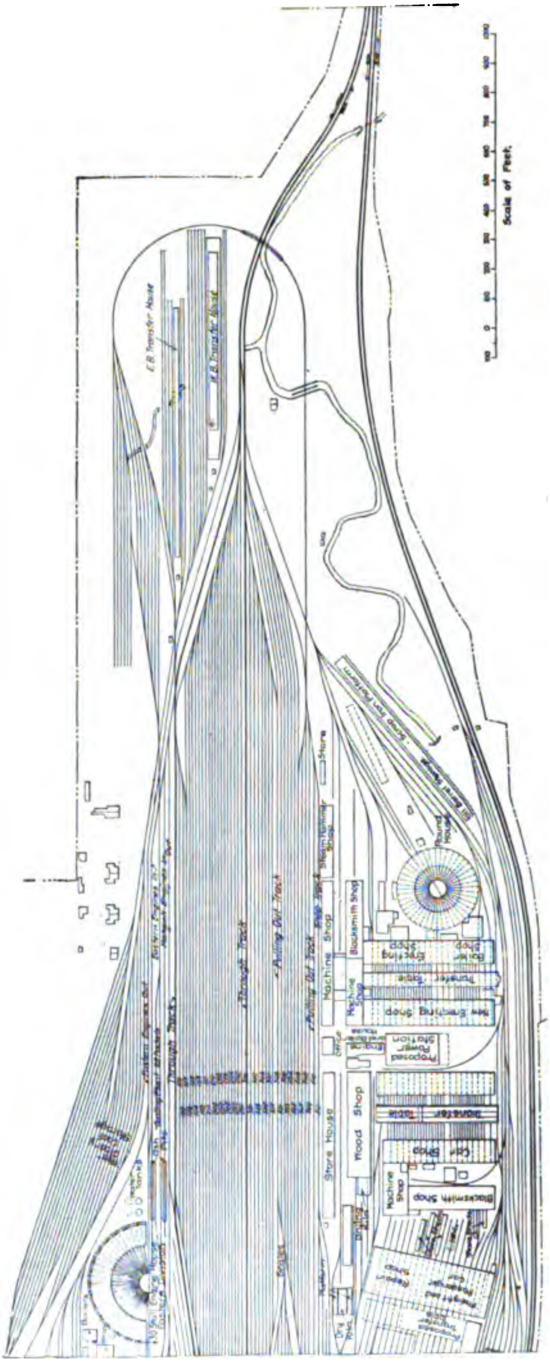


FIG. 41.—West Albany freight yards—New York Central & Hudson River.

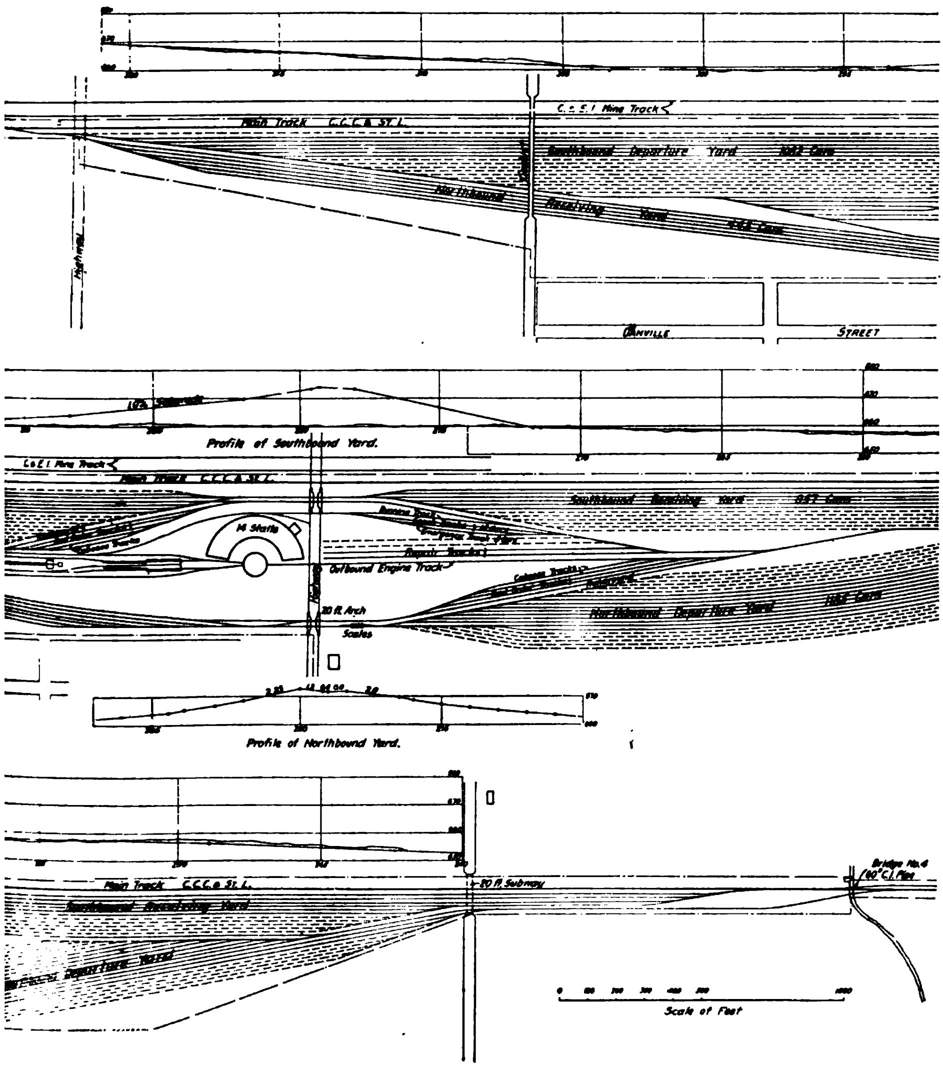

C. & E. I. Mine Track
Main Track C.C.C. & St. L.
Southbound Departure Yard 1082 Cars
Northbound Receiving Yard 948 Cars
Highway
Danville Street
Profile of Southbound Yard.
C. & E. I. Mine Track
Southbound Receiving Yard 857 Cars
14 Stalls
Outbound Engine Track
Repair Tracks
Caboose Tracks
20 ft. Arch
Scales
Northbound Departure Yard 1185 Cars
Profile of Northbound Yard.
Main Track C.C.C. & St. L.
20 ft. Subway
Southbound Receiving Yard
Departure Yard
Bridge No. 4 (60" C. I. Pipe
0 100 200 300 400 500 1000
Scale of Feet

FIG. 42.—Yards at Lyons, Ill.—Big Four.

Trains are made up here for convenience of delivery to connecting lines or consignees at Chicago. The traffic is mostly coal. The hump feature was closely studied with a view to giving cars, or cuts of cars, the proper acceleration to send them over the scales at a speed of about 4 miles an hour, to ensure efficient operation of the automatic weighing device; and then by further acceleration to cause the cars to pass by gravity alone to the desired location is the yard. The northbound hump represents the latest studies of the engineers in this connection.

The new freight yard of the Lake Shore at Elkhart, Ind., was put in operation in the spring of 1904 and is a division terminal, classifying freight in both directions. It was built to relieve congestion at transfer points near Chicago. The Elkhart terminal lies entirely on one side of the passenger tracks. Between the receiving yard and the classification yard in each direction, a summit has been built to facilitate the separating. The length of this terminal is nearly 4 miles. The eastbound receiving yard consists of five tracks holding from 88 to 90 cars each. About the middle of the receiving yard is a series of cross-overs to permit of trains being divided up so that each section can be handled separately. The classification yard holds about 836 cars. The descending grade, from the summit, is 4.3 per cent.

The summit feature may be utilized to feed cars to loading and unloading points, such as coaling stations, large boiler plants for power houses, ash-track conveyors, freight-houses, etc., and this has in many cases effected considerable economies and improved handling generally.

Interesting problems are encountered in locating scales in summit yards. Ordinarily the scales are placed just beyond the summit. When out of repair, this may seriously interfere with the handling, especially when a large precentage of cars passing over the summit have to be weighed. In some yards two sets of scales are installed and used alternately.

The Pennsylvania yard at Sheridan, Pa., is an example of development. Over 2000 cars, eastbound, have been handled in 24 hours; ordinarily 450 are weighed and at times, 685. A train of 35 cars can be put over the hump and separated into 30 cuts, in 25 minutes.

The Harrisburg yards of the Pennsylvania have grown to 10,000 cars, capacity—109 miles of track. A consolidation engine, weighing 193,000 lb., can push 130 cars over the hump. When the thermometer falls below 25 degrees, a second engine is put in service. Seventy-two eastward trains, with 3750 cars; and 66 westward trains with 3644 cars, have been started in 24 hours.

The Conway yards of the Pennsylvania lines, like Harrisburg, are a collection of units in which the summit switching method is used. The standing capacity is 8967 cars—the daily movement 2300 cars, with a maximum of 2638. Under favorable conditions an 80-car train is broken up into 60 cuts in an hour.

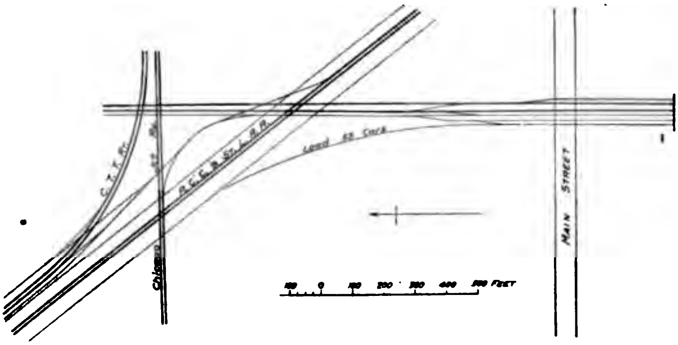
The Chicago & Eastern Illinois yards at Dolton, near Chicago, Fig. 43, have had a number of additions to increase their capacity, efficiency and flexibilty of operation. One of the most important changes was in the hump of each yard, made by raising the grade of each run-around track to the elevation shown; the northward yard having the knuckle of the run-around 1.27 ft. higher than the knuckle of the scale track.

Car movements over each hump are controlled by a semaphore operated by the man in charge of the hump. Three special hump switching engines were built for this service—of the 0-8-0 type—220,000 lbs. total, all on drivers; 23.5-in. × 32-in. cylinders, 57-in. drivers, 200 lbs. steam pressure. Their tanks will hold 8000 gallons of water, so as to minimize the number of trips to the water crane. There are also 14 engines for general yard work—0-6-0 type—21 × 26 cylinders, 51-in. drivers and 5500 gallons capacity tanks.

There are so many conditions governing terminal switching that an actual case of switching by continued gravity alone is not in use where winter weather is severe. There are many yards in which cars are dropped into the tracks of a separating or classification yard during many months of the year by gravity, without the assistance of poling, a summit, or "kicking." Except in the mild climates, however, where extremes of temperature are infrequent it is probably not practicable to construct a gravity yard that can be successfully operated as such with all kinds of cars and loads during twelve months of the year. If the grade is sufficiently heavy to start a car during very cold weather, the speed attained on such a grade during warm weather will be excessive, and, on the other hand, if the grade is right to permit of safe handling during summer, there will be times during winter when cars will not start and the assistance of an engine becomes necessary.

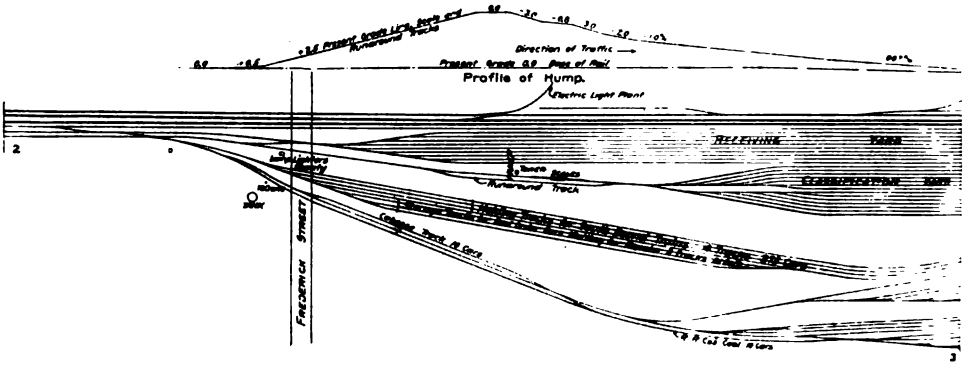
A terminal worked by gravity solely during the greater part of the year may, for all practical purposes, be properly termed a gravity yard, that is, one wherein a car, or a number of cars coupled together will start on releasing the brakes. To accomplish this, grades from 0.8 to 1.0 per cent. are necessary. In many instances even 1.0 per cent. grade will not be sufficient to start a car, as for instance, when the journals and packing in the boxes have become thoroughly chilled or when the opposite extreme, an excessively hot box exists, or has recently existed. The Columbus, Ohio, yards of the Pennsylvania Company (Fig. 44) are assisted by gravity, and consist of a collection of units. The entire yards were remodeled not long ago.

With the use of much lighter and smaller cars, and an arrangement whereby brakemen can apply brakes from the side, gravity switching is in more general and satisfactory use in Europe than in America. There



North end of southbound Dolton yard—Chicago & Eastern Illinois.

(This section joins with 2.)



Middle section of southbound Dolton yard—Chicago & Eastern Illinois.

(This section joins with 1 and 4.)

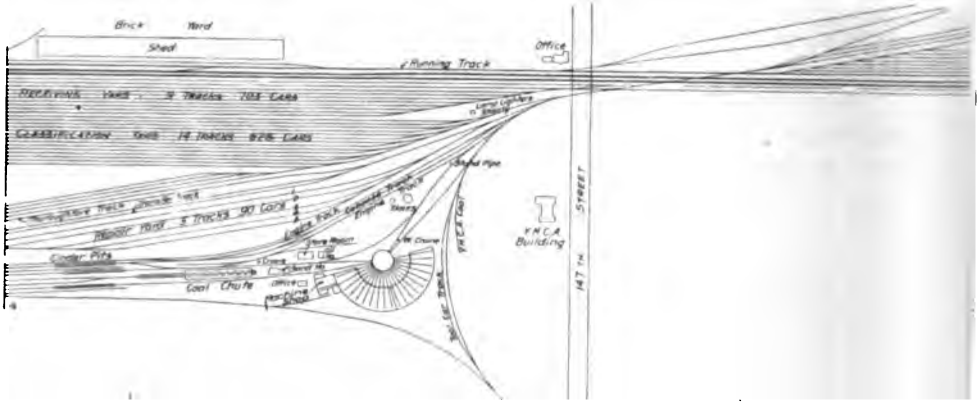
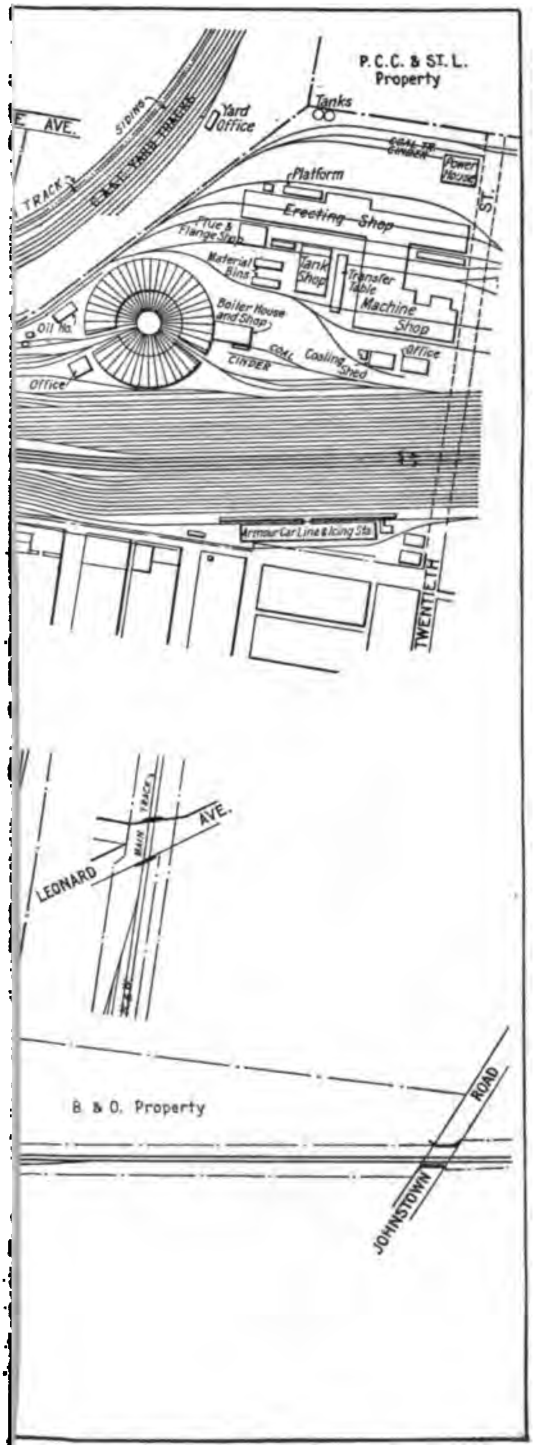

Brick Yard
Shed
Running Track
Office
Receiving Yard 9 Tracks 703 Cars
Classification Yard 14 Tracks 826 Cars
Repair Yard 5 Tracks 90 Cars
Cinder Pits
Coal Chute
Office
Y.M.C.A. Building
147 th Street
4

FIG. 43.—South end of southbound Dolton yards—Chicago & Eastern Illinois.


P.C.C. & ST. L.
Property
Tanks
Yard
Office
E AVE.
SIDING
TRACK
EAST YARD TRACKS
COAL TR.
CINDER
Power
House
Platform
Erecting Shop
Flue &
Flange Shop
Material
Bins
Tank
Shop
Transfer
Table
Machine
Shop
Boiler House
and Shop
Oil Ho.
Office
COAL
CINDER
Cooling
Shed
Office
Armour Car Line & Icing Sta.
TWENTIETH
ST.
LEONARD
AVE.
MAIN TRACKS
B. & O. Property
JOHNSTOWN
ROAD

they also use "shoes" to assist in stopping cars. These are chocks made to fit over the rails in such a manner as to force the car wheels to run up the inclined upper side of the shoe, from which they roll back again, releasing the shoe. "Chain drags" are used too, to catch runaway cars. This is a large heavy chain located in the track in such a way that a switchman by throwing a lever causes the hook at one end of the chain to engage with an axle under the car and the dragging of the chain gradually brings the car to a standstill.

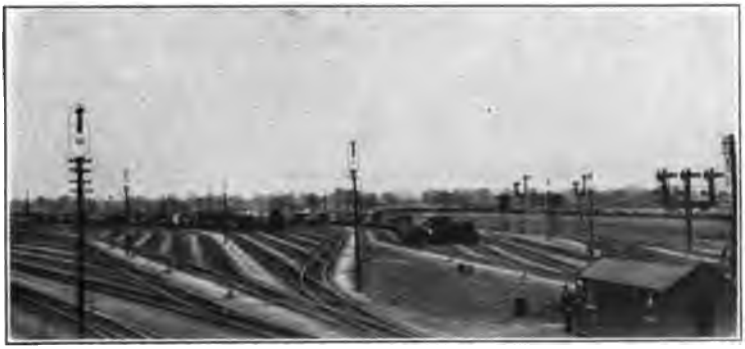


Fig. 45.—Goods switching yards, Crewe, England—London & North-Western.

It is apparent that the first cost of a gravity yard is prohibitive unless the lay-of-the-land happens to be quite nearly adapted to it naturally. In 1873 the Edge Hill yard at Liverpool, England, (Fig. 25), was designed and the work of construction begun. Its design is still considered one of the best for the prompt and economical distribution of cars. It is commonly believed to be the first yard of any importance constructed on the so-called "gridiron" plan for classifying cars by

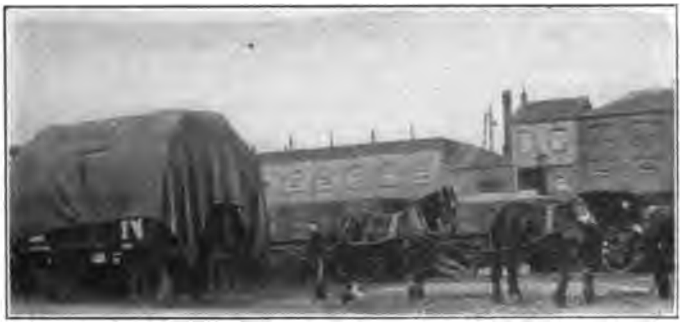


Fig. 46.—Switching horses, England—Great Northern.

gravity. It is also generally assumed that it was the first to use an advanced method of switching on a large scale and to abandon the old "push and pull" or "link-and-pin" process, for classifying cars. It was not unduly costly, for nature had shaped its topography in a wonderful way at the precise spot where the yard was needed.

A gravity yard was put in operation in 1846 at Dresden, Germany, and is remarkable for its high cost of construction. At the upper end a fill 70 ft. high was necessary. From an operating standpoint this proved very satisfactory. It is about one and a half miles long and half a mile wide. This Dresden yard is probably the one in which the first gravity switching was done in Germany.

The conditions in England are different, principally by reason of the small car and predominating fast freight service. The view of the Crewe (London & North Western) "goods switching siding" (Fig. 45) shows an interesting and pretty bit of railroad scenery. The "shunting" horses at work on the Great Northern (Fig. 46) are perhaps novel to many, although horses were used to shunt cars in many places in this country years ago before our cars grew in weight and capacity.

CHAPTER VI

OPERATION OF YARDS

Yard or terminal operation differs from most other administrative work, in that the actual arrangement and execution is only its beginning. The vastly greater and more important duty of the executive head consists of constant vigilance and alertness in estimating the flow and nature of traffic, and providing an easy channel for it. He must know what the situation is every hour and minute of the day and night, not only as to local conditions, but also as to approaching train and car movements, and must know what is required to dispose of the traffic promptly and certainly, while at the same time arranging for outward movements and interior exchanges.

The yardmaster who handles a small yard with two or three yard engines (the so-called "switchman yardmaster," who graduated from the ranks and knows the work of "following an engine" from center to circumference) and the yardmaster who handles a large terminal covering many miles of territory and many combinations of yards, and who works twenty or more engines, may both be men of ability, but of very different caliber. Both must be men of the hour, men of initiative and resourcefulness. As one prominent leader puts it, what is needed is "action—consistent, insistent, persistent."

The position of yardmaster calls for administrative and executive capacity. He should be thoroughly familiar with all the details of the work of his subordinates, but he can better devote his time in supervising than in falling into the common error of attempting to do the work of a switchman or clerk. The late Mr. E. H. Harriman's remarks about a general manager aptly apply: "I want to see him with his feet on his desk—thinking, thinking!" It is easy to fall into and follow a rut. Constant agitation is necessary to prevent it. Things jar one's nerves to-day; to-morrow the edges have been rounded off and the day after nothing out of the ordinary is observed. Constant study and investigation is beneficial to determine whether:

New cross-overs are needed.
Existing cross-overs can be relocated or turned around to advantage.
Leads can be extended to keep engines off main tracks.
Ladders should be rearranged.
Scales may be more advantageously located.
Switches can be taken into interlocking systems.
Signals should be changed or relocated.

Additional water-cranes should be erected or existing ones located to better advantage.

Engines turned around may work better.

Train make-up may be improved to save switching somewhere.

Handling of cars may be reduced.

Too many cars are being handled in switching—in some cases unnecessarily fouling main tracks or leads.

Unnecessary switching or "spotting" is being done at freight-houses, transfers, and similar points.

Too many cars are handled in transfer movements, causing loss of time to transfers and other trains or engines.

Houses and transfers are pulled oftener than necessary.

Industry tracks schedules enable work to be done at times when there is a minimum of main track interference or conflict with other yard engines.

Local freights arrive and leave at hours when they can be handled to best advantage.

Local freights can be run nights to relieve other conditions.

Delays are due to slow furnishing of supplies or inconvenient method of getting them.

Time engines are coaled or watered is the most advantageous.

Hours for relieving engines are suitable.

Time is lost nights, or day or night in winter, by crew not getting in motion promptly after engines' absence for any purpose.

There are other loose ends to be gathered up. Constant watching, eternal vigilance, leads to prompt and economical service.

The operation of yards in relation to train service covers, broadly, the handling of in and out car movements with all the accessories connected with the care of engines and cabooses, such as engine-houses, coaling plants, ash-pits, sand plants, water stations, repair shops and supply depots. A general analysis of the features of receiving and forwarding trains and handling of cars, disposes of the units of which an inbound train is composed, in one or more of the following movements:

1. Engine to engine-house for return or continuance of trip.
2. Caboose to track provided, or to an outbound train.
3. Cars to be held for orders:
   (a) Diversion (loads),
   (b) Orders of car distributor (empties),
   (c) For anticipated traffic (empties).
4. Cars to be forwarded in other trains.
5. Cars for connections.
6. Cars for industrial sidings.
7. Cars containing package or l.c.l. (less than car load) freight for freight-houses.
8. Cars containing bulk or c. l. (car load) freight for team delivery tracks.
9. Empty cars to be held until needed.
10. Cars containing company material taking various points of delivery.

Many of these cars, before being placed as indicated above, must be weighed, repaired or transferred, and frequently go through two or all of these processes.

In assembling cars for outward movement the divisions, commonly termed "classifications," are more varied and complicated because of the large number of diverging routes and destinations to be considered. These are governed largely by the capacity of the terminal to arrange the trains without impeding the movement of traffic, and the capacity of terminals (in advance or following) to care for their tributary territories. The following are some of the features entering into the assembling of outward trains:

1. Destination of cars.
2. Character of contents—(*e.g.*, live stock, perishable freight, time freight, export freight, etc.).
3. Character of trains—(*e.g.*, fast or symbol freight, through ordinary freight, drop or switching locals, local or package freight trains).
4. The general policy of train classification.

Much can be said regarding the general policy of a railroad in reference to classification of trains. In making up local freights, the work is usually done according to methods best adapted to the division. The common method is to place cars in station order. The first cars to be set off are put next to the engine, next the cars for the second station and so on, to enable them to be set out with the least possible switching. In many cases, the merchandise cars (also known as platform, peddler, break-bulk, l.c.l. or package cars) are kept on the rear for the two-fold purpose of enabling the engine crew and part of the train crew to set off or take on the station cars, while the remainder of the train crew loads or unloads the package freight from or to the freight-house opposite the rear end of the train. The conductor, with his waybills, and a part of the train crew, is then enabled to reach the platform cars quickly from the caboose. Unfortunately it is more often the practice to make up the local freights with no attention whatever to car arrangement, usually because the yard is inadequate and hardly able to classify the through freights properly, thus causing the most important trains (the divisions locals) to be neglected.

If the cars picked up on the road are kept together in the train according to destinations, it increases the road work and decreases the yard work. On the other hand, if they are picked up indiscriminately, the reverse is true. The classifications to be made at the initial point of a through train and maintained at each successive "breaking-up" point, are governed by the road's general policy and are, or should be, dependent on the ability of each general or divisional terminal to do its part of the work, or care for a part of the work a weaker terminal is unable to perform; on the necessity for fast time; on the character of the traffic; and on the number of diverging routes, and connecting lines.

In very general terms, the policy may consist of one of two methods:

1. No classification is to be attempted until last yard of the road or division is reached, where cars going beyond are separated.
2. Originating and all subsequent yards to arrange cars in groups for final and intermediate deliveries.

If the railroad serves a few large cities, toward which traffic naturally gravitates, the second method will entail more work than the first. If the larger terminals are inadequate, the first method will reduce the work in them, and correspondingly prevent delay or congestion therein. At the same time it will undoubtedly add to the expense and detention in the terminals in advance. In practice, a compromise between the two methods will usually be found most economical and expeditious. A fast or important freight train should be made up at its originating point classified to final destination on the home road, and it is not infrequently desirable to classify to a considerable distance beyond on the line participating in the fast freight service. It is a very good general proposition to make up as many straight trains (fast and ordinary freight) to distant points as can be assembled within a reasonable period of time, if the switching facilities at such originating points are ample and sufficiently well balanced for this purpose. These trains should be made up solid for points as far distant as practicable. A general rule under which cars are held for a solid train for any point to which there are sufficient cars to make such a train every 24 hours, has worked out successfully on one road. In many instances freight would be more expeditiously handled by holding 48 hours, or even longer, as compared with the "potpourri" method. Holding the cars at the originating terminal for this purpose keeps them out of many intermediate yards and saves extra handling. The remaining freight may then be more advantageously moved by following out a line of final classification under the first method. Actual mathematical analysis will prove that when trains can be made up solid to final destinations, the first method will actually reduce the switching of cars.

It is the purpose of this work to avoid expressing the views of one individual alone and perferably to present both sides of every discussion and the various opinions of those who have given them thought. An interesting dissenter to the second method of classification is the Railway-Age-Gazette, as follows:

"The matter of switching can easily be overdone. It sounds very well to talk of lining up a train at a hump near Chicago so that it can run through solid to New York. There are so many other terminals to be encountered en route that this admirable theory seldom works out in practice. To begin several hundred miles back to get cars in a certain order at *A* or *B* to save switching at *Z*, the final terminal, is misleading. It is like sitting up all night to avoid oversleeping in the morning. Perchance at *B* there is a car for *E* between two cars for *Z*. Why then switch out at *B*, when by the set out at *E* the switch has made itself? Again, a car becoming bad order and switched out along the road may save a switch at the terminal.

This view voices the opinion of a very respectable minority of practical operating men, who claim that true economy delays the making of a switch to the last terminal possible. They would require each division to do its own switching except in the case of certain fast trains handling special high class freight. They claim that the ideal conditions justifying initial classification for distant terminals are almost never realized in practice. The ruling grades on various intermediate divisions are so different that it is seldom possible to balance the motive power so as to maintain a train of uniform tonnage over all divisions. Some of the officials go even further and claim that, as a rule, switching in station order for the next division is a fallacy born of the trainmen's disinclination to extra exertion. The irresistible conclusion of their reasoning is a minimum number of classification tracks at intermediate terminals."

It is customary to use worn-out or light engines for yard work. Light engines are suitable for certain kinds of yard work, and in such cases there can be no possible objection to them, but in many instances their use in yard service is uneconomical. An engine in a classification yard should be sufficiently powerful to handle as many cars as a road engine brings in, and to start them quickly. It requires just as many men to man and follow a small worn-out engine as a larger engine designed for this class of service, and it usually burns as much coal, while the larger engine will perform much more work. Two engines in a yard will usually interfere with each other and, of course, also interfere more with road engines than will one. It is questionable economy to use in yard service road engines not adapted for quick starting and stopping, and from which signals cannot readily be seen, fore and aft, and from either side.

One of the first desiderata in a yard is the delivery of incoming trains with regularity, and another of nearly equal importance is to have outgoing trains start as soon as they are ready. This is almost wholly within the province of the chief train dispatcher and, barring shortage or bad condition of locomotives, he may substantially carry out the yardmaster's wishes; or, in edging over, one way or the other, he may materially embarrass him. Thorough harmony and frequent conference are necessary. A yardmaster dreads having a number of ordinary freight trains coming in just ahead of a stock or other fast freight train demanding preferred attention. In such matters the chief train dispatcher can greatly assist the yardmaster by keeping the yard informed as to the road conditions, and in turn, informing himself as to yard conditions. The holding back of freight trains may on the other hand be carried to excess and result in greater embarrassment if they finally come in "bunched" faster than they can be comfortably handled. There is a line to hew to in this as in many other things, and it is the intelligent chief train dispatcher with a good supply of common sense and discretion who finds it. When freight is heavy, and weather conditions are unfavorable, the chief dispatcher in figuring ahead, may keep the terminal well supplied with power for outward movements by adjusting the tonnage rating of locomotives to weather changes and by insisting on good dispatching. This will also do much toward getting trains over the road promptly. If the locomotives are overloaded or if the trains are neglected on the road—remaining too long on sidings—neither the locomotives nor the men will be available for early use when they get into the terminal. Unless there is an abundance of motive power and men, a congestion may result because of inability to start trains out when they are ready. The situation becomes aggravated by the necessity for holding out approaching trains because of such congestion. This in turn renders more locomotives and more men unfit for service.

The chief dispatcher should watch the tonnage rating and make readjustments as frequently as conditions make them necessary. The government weather report should be had from the nearest signal station, both the full detailed daily mail reports and the more frequent brief telegraphic advices. Weather reports by wire must also be had from designated railroad telegraph stations along the line at stated times, and during threatened or existing storms at additional times. Close watching of these reports and other data will often keep a road open and going where a little neglect would cause a blockade. A train must never be permitted to become stalled in a snow storm if there is any possible way to prevent it. The temperature reports sent at regular intervals from the different stations are of great value.

Much may be accomplished by having everything in readiness at all points—the decks should always be cleared for action. Enormous delays occur in many yards made up, in the aggregate, of very small and almost unnoticeable items. The failure or neglect to have switching lists, instructions and other clerical matter in readiness for assistant yardmasters or conductors going on duty, is more expensive than would be supposed, because it holds up the work of an entire crew while the conductor is getting instructions. It may be but 10 or 15 minutes, but at an approximate cost of 6 cents a minute it means a loss of 60 or 90 cents. The composition of approaching trains should be known in ample time to communicate the information to yard conductors and others requiring it, so that they may be ready to take hold quickly after these trains pull in. Time may be saved by arranging fixed signals to tell enginemen of yard engines which moves are wanted, instead of having them depend entirely on the hand signals of trainman. The enginemen then need look only in one direction for signals. This is especially adaptable to engines employed in hump switching.

Delays often ensue because car inspectors do not inspect trains and couple up hose early enough to enable the trains to start on time. After snow storms there may be delay in cleaning out yard switches, thus preventing full use of the power and men. If repair tracks are awkwardly located the time of switching the crippled cars may sometimes be changed to reduce the interference with the forwarding of loaded cars. Signal lights may be relocated or added to facilitate transmission of signals and reduce liability of confusing them. Every added facility in the way of office conveniences, filing systems, record books, bill racks, telephone and telegraph connections, assists in securing economical results.

On the arrival of a freight train, the yard clerk (sometimes called a "checker" or "chalker") goes along one side of the cars with a switch-list showing car numbers, initials, contents and destinations, checks off the seals and notes their numbers and condition in the proper columns. In some yards the clerk takes the card bills handed to him in a package, by the conductor. The card for the first car is on top and the others are arranged to follow in regular order. The cards are checked against the train and the seal records noted and are afterward copied in a permanent record. In his inspection, going down one side of the train and returning on the other side, he also notes the condition of the doors. The cars are marked on the switching side, so as to indicate to the yard conductor where the cuts should be made and the tracks to which they should be switched. The marking is done by carding or chalking. When a card is used it is usually of a distinctive color and has a large plain letter or number representing the final destination within the terminal, or the train and division for outward movement. The card is tacked on the side of the car near one end. When chalk is used, the number or letter or abbreviation for destination, and the date, are noted thus: "B 3/20," meaning the destination or route for which "B" stands, and March 20. Chalk is cheaper than talcum; is easier to mark with and more readily effaced by rubbing or by rain. The permanence of marking is objectionable because a number of marks on a car would be confusing.

The disposition of the power to the best advantage, with a system for checking it; the knowlege that it is kept moving without making false or unnecessary moves; that it is kept properly balanced; and that it reaches the point where cars require movement; these are prime essentials of successful and satisfactory operation. Regular engine schedules should be maintained so far as practicable; but while every effort should be made to maintain them, there should not be the slightest hesitancy in discontinuing or readjusting them as conditions change and seem to warrant. In many large terminals, a system of train dispatching by the use of telegraph or telephone lines is in effect. A dispatcher may be assigned to keep records of engine movements at the various reporting stations and perform additional duties. He should follow up and demand an explanation of apparent detentions. In one terminal a record board is used instead of the ordinary train sheet. The board is ruled in squares, with a peg hole in each square. Each yard engine is represented by a peg with the engine number on it. Horizontal lines represent reporting stations; vertical lines half-hour divisions progressing from left to right, there being 48 to represent a 24-hour period. The arrangement is on the general plan of a time chart. As the engines are reported they are moved to the corresponding peg hole, at the intersection of the horizontal line representing the reporting station and the vertical line representing the nearest half-hour division to the time at which the report is received. The peg remains in the hole until the next report of the engine's movement is received. The movements may be copied on a train sheet for permanent record and subsequent study by the yardmaster.

To work up a perfect set of yard engine schedules in a heavy and complicated terminals, is a task of no mean dimensions. The road movements, both in and out, must be met on one side, and on the other the interior movements, which include the freight-house and transfer work and the placing of cars on private industry tracks, in engine-house, coal trestle and team yards, all of which must be dove-tailed smoothly and accurately. Each private industry track should be visited once in 24 hours on working days, and at about the same hour each day. If the plant is working it should not be omitted. On the other hand, it should not be attempted oftener, as other industrial plants may claim discrimination unless similar service is given them, and this is usually impracticable. In some instances more frequent switching is given for operating convenience; it may be necessary to bring about a more prompt release of cars at a time when cars are in demand.

The use of relief engines is advocated. This enables regular yard shifts to continue work while the relief engine substitutes for those requiring coal, sand, water, fires cleaned or light repairs. In some sections of the country the "eight-hour yards" are in vogue. Overtime is not usually permitted in these and no time is allowed for meals, it being the theory that the three shifts cover a 24-hour period without intermission, a theory which may work out satisfactorily in a classification yard, operated day and night every day in the year. It is uneconomical and awkward in commercial yards where the work may be done by an engine in 10 hours 1 day and where 12 hours or 14 hours are required the next. The 8-hour arrangement as usually applied permits economical work only in multiples of 8—that is, 8, 16 or 24 hours because of the prohibited overtime.

To get the best results, the power should be very carefully assigned after the schedules have been mapped out. Light engines, with short wheel base, should be used on curves of short radii or where structures are weak. Freight cars, coupled, may be moved around curves of 150-ft. radius, (38 degrees), but engines of ordinary design will not go around such curves. An ordinary road engine will go around a curve of 318-ft. radius (18 degrees). By cutting away between engine and tender to permit short turning, and separating cars by bar-couplings, curves of 100-ft. radius (57.6 degrees) may be operated. The heavier power should be placed where tracks, bridges and curves will permit and where heavy tractive power can be utilized to advantage.

The Edge Hill yard of the London & North Western, Liverpool, England (built in 1873), was one of the first to use gravity, abandoning the "push-and-pull" method and working on the gridiron plan. It is to-day one of the most interesting and instructive car-handling machines. 2000 to 2500 cars ("waggons") come in every afternoon and evening from the various docks, quays and depots around Liverpool. From the "reception lines," near the summit, where the road engines leave the cars, they are sorted by gravity into the "upper group" of storage sidings, consisting of 24 parallel lines, each taking the cars for a particular train. Just before a train is ready to leave, its cars are dropped into one of the "departure lines" through two groups of short tracks called "gridirons." In these short tracks the positions of the cars are changed to station order. The entire work is done by gravity, no power being applied at any point, the grade being sufficient to start a car when its brakes are released. At the neck of each group of lines, a "sand-drag" is arranged to stop run-away cars. The Edge Hill yard is described in another chapter.

The plans of the Brunswick, Md. yards of the Baltimore & Ohio (Fig. 39, page 91) have been discussed. They have a capacity of 6500 cars and handle upward of 2000 cars daily in each direction when business runs heavy. The eastbound classification yards have 36 tracks, 18 in each, using a central ladder scheme on each side, with nine tracks to a ladder. An electro-pneumatic push button machine operates the switches. A brakeman tags the cars as they come from the receiving yard to the hump. For example, if a train pulls into the receiving yard with the first 10 cars for Washington and the next 20 for Baltimore, a tag reading "10-4" is put on the front of the first 10 cars, indicating that the first 10 cars in the shift are to go on the Washington track in the classification yard. The next 20 are tagged in a similar way for Baltimore. The outlet from the classification yard is by double ladders through the center of the yard and a single ladder on each side, each ladder having nine switches. Trains from the northern half of the classification yard pull directly out on the eastbound freight track.

The Potomac yard of the Washington Southern, at Alexandria, Va., is a large, two-direction hump, in which about 1100 cars are received and the same number forwarded daily under normal conditions. A plan and description appears in Fig. 34, page 82. Twenty-seven "undisturbed" classifications are made northward, 26 southward; one track is used for "mixed" classifications. The cars on the latter track must be reclassified as the tracks in the southbound yard are insufficient to enable the necessary 29 classifications to be made. Six engines are worked nights and five during the day. Two engines work continuously on the humps, with six car riders, a cutter, a conductor and four switchers for each engine. About 20 per cent. of northbound and 50 per cent. of southbound cars are weighed.

The yard forces employed in the Chicago terminal district of the Chicago & Northwestern include about 700 men. On a basis of 10 hours' service as an "equivalent engine day," 105 engines are worked daily in the terminal territory. Of these, 60 work days and 45 nights. This requires about 70 *actual* engines, including those in the shops at any one time. The engine crew consists of an engineman, a fireman, with three or sometimes four switchmen to each engine. There are 24 yardmasters employed (including general yardmasters, yardmasters and assistant yardmasters), 40 switch tenders and 80 yard clerks or markers. In the 40th Avenue yard there are 34 engine crews, 17 working days and 17 working nights. Eight of the 16 transfer crews work out of 40th Avenue. The Wisconsin division yard force there is composed of one general yardmaster, 11 yardmasters and assistant yardmasters, 24 yard clerks, 4 train clerks and 8 switch tenders. This includes both day and night forces. It does not include the office force (5 men) of the trainmaster of freight terminals, whose office is in the former 40th Street depot shown on the map (page 93) at the junction of the 40th Avenue yard with the Galena division, nor the agent's force, which includes 18 general clerks, whose whole time is taken up in billing out the cars.

The tables on pages 112 and 113, compiled from the various details of operation of yards, gathered by the Committee of the American Railway Engineering Assocation, give some interesting features. It was with much hesitancy that the column "Cost per car handled" was added, because conditions and viewpoints vary so greatly that it may seem unfair to well-designed and well-handled yards. The higher costs may be indicative of close work. Or they may be due to a closer analysis of the situation and the establishment of a basis which includes every expense entering into yard operations, as well as a scrupulously correct count of the number of cars handled.

In the Lake Shore's Elkhart and Collinwood yards, the number of riders employed is dependent upon advices as to composition and number of approaching trains. In other yards it is based upon the number of cars passing over the hump during the working period of the day. In the Altoona yard of Pennsylvania a record was kept to determine the number of cars and cuts each rider was capable of riding for the entire day; it being placed at about 28 cuts in 12 hours. The number of riders to be assigned to each hump is then arived at. In the Reading. yard at Rutherford, Pa., 16 or 17 cuts are classified in from 5 to 7 minutes. If there are more cuts in a train the work has to await the return of the riders. In some instances, therefore, trains are classified at upward of 400 cars an hour, for very short periods. The East St. Louis yards assign the riders from a forecast of business given to the general yardmaster.

In weighing cars the general practice is to uncouple them, whether they are weighed while running over the scales on the descending side of a hump or on a separate track for that purpose. In a few cases they are weighed without uncoupling. Riders usually walk back to the humps, an engine being run down to meet them if there is likely to be a wait. In a few cases provision is made for returning them more quickly. At Altoona, a pick-up car, handled by a small engine, operates on a track for that purpose, running alongside the extreme north side of the east-bound yard. It would be preferable if this track ran in the center of the yard, but it would probably interfere with the switching work. In the Conway (Penna.) yard, a pusher engine is used to shove out tracks in the classification yard and also carries riders back. In a few other yards electric trolley cars are used to return the riders. Current is obtained from a nearby company power-house.

Ladder track switches leading into the body tracks of classification yards are usually thrown by hand and it will be seen from the table that one man usually covers from 8 to 10 switches. In the Altoona yards they are operated by direct move electro-pneumatic power controlled from the tower by a push-button machine. In the Enola yards (P.R.R.), one man at each hump operates the switches by compressed air.

The Lake Shore & Michigan Southern uses a heavy type of locomotive (135 tons) to push cars over the humps at Collinwood. Some roads use two engines. The Chicago, Indianna & Southern at Gibson, Ind., uses an engine weighing 270,000 lb. on drivers. The Norfolk & Western at Bluefield, W. Va., uses a 90-ton engine—two engines in emergencies.

In switching over a hump, a uniform speed of about 2 miles per hour should be maintained without a stop, until all the riders are taken up. If cars do not run freely a second engine, equipped for poling, may be placed alongside the ladder and used to good advantage in starting stopped cars and keeping switches and entrances to body tracks open. With low temperature or during a heavy snow storm, this will greatly aid the movement.

OPERATING RESULTS IN LEADING YARDS

Yard	Max. number trains rec'd in an hour	Av'ge cars per train	Av'ge No. trains rec'd in 24 hr.	Train one engine can push over hump		Av'ge cuts per train	Per cent. cars w'gh'd over hump	Un-couple to weigh	Scales on hump	Dist. from sum-mit (feet)	Average classifying capacity of hump in continuous operation				No. car riders	Switches to each switchman	Cost per car
				Cars	Tons						1 hr.	5 hr.	10 hr.	24 hr.			
Brunswick, Md. . . . . E.	6	45	30	40	3350	23	2	Yes	No	. . . . . .	50	250	500	. . . .	11	Electric	10.0
Newcastle, Pa.	4	50	12	. . . . . .	2500	28	30	Yes	Yes	50	25–75	125–375	250–750	600–1700	5	14	8.5
Holloway, O.	4	34	15	34	1913	15	70	Yes	Yes	127	20–70	100–350	200–700	400–1400	7	9	11.0
Winnipeg, Can.	5	50	40	. . . . . .	2500	25	0	. . . . .	. . . . . .	. . . . . .	100	. . . . . .	500	. . . .	8	12	5.0
Haney, Ills. . . . . N.	4	51	18	51	. . . . . .	35	20	Yes	Yes	110	85	425	850	. . . .	14	8	10.0
Galesburg, Ills.	8	51	50	51	1559	31	25	Yes	Yes	50	100	500	1000	3000	10	7	11.9
Gibson, Ind.	6	40	7	60	3840	. . . . . .	0	. . . . . .	. . . . . .	. . . . . .	100	500	1000	2000	20	7	. . . . . .
Oneonta, N. Y.	9	43	30	43	2300	28	1	Yes	No	. . . . . .	32–50	160–250	320–520	640–1000	7	4	10.9
Pen Horn, N. J.	8	25	40	25	. . . . . .	20	0	Yes	No	. . . . . .	50–75	250	500	1000	12	10	9.0
Elkhart, Ind. . . . . E.	6	75	15	75	. . . . . .	35	4	Yes	No	. . . . . .	. . . . . .	. . . . . .	. . . .	2500	8	6	9.0
Collinwood, O. . . . . W.	6	75	20	75	. . . . . .	40	4	Yes	No	. . . . . .	. . . . . .	. . . . . .	. . . .	2000	10	6	9.0
Oak Island, N. J.	6	35	15	20	900	20	0	. . . . . .	No	. . . . . .	100	500	1000	2400	4	10	6.5
River Rouge, Mich.	3	65	10	65	. . . . . .	30	3	No	No	. . . . . .	80	400	800	800	4	10	. . . . . .
East Bottom, Mo.	10	40	36	. . . . . .	1500	25	15	Yes	Yes	50	30–50	150–250	300–500	600–1000	8	8	27.0
Avis, Pa.	8	60	20	. . . . . .	. . . . . .	42	98	Yes	Yes	80	38–70	. . . .	500–620	850–1100	4	8	8.9

Where one set of figures are shown, under "classifying capacity of hump" they represent the average. Where two sets the small number represents the average and the large the maximum.

Cost per car is supposed to cover the expense of handling from the time the road engine cuts off on receiving track until the road engine is coupled to the train on departure track.

OPERATING RESULTS IN LEADING YARDS—*Continued*

Yard	Max. No. trains rec'd in an hour	Av'ge cars per train	Av'ge No. trains rec'd in 24 hr.	Train one engine can push over hump		Av'ge cuts per train	Per cent. cars w'gh'd over hump	Un-couple to weigh	Scales on hump	Dist. from sum-mit (feet)	Average classifying capacity of hump in continuous operation				No. car riders	Switches to each switchman	Cost per car
				Cars	Tons						1 hr.	5 hr.	10 hr.	24 hr.			
West Albany, N. Y.........E.	7	50	29	......	......	40	2	Yes	No	......	95–160	400–500	800–1123	1600–2000	6	6	28.0
West Albany, N. Y.......W.	7	35	35	......	......	28	2	Yes	No	......	95–160	400–500	800–1125	1600–2000	6	7	28.0
Dewitt, N. Y.............E.	5	75	50	......	3300	35	1	Yes	No	......	200–300	....	2000–2783	....	12	6	10.2
Dewitt, N. Y............W.	5	80	35	......	3300	42	1	Yes	No	......	200–300	....	2000–2783	....	12	6	10.2
Williamston, W. Va........	11	60	24	......	......	60	95	Yes	Yes	75	40	180	300	350	10	10	11.0
Bluefield, W. Va............	7	30	24	......	......	30	80	......	......	......	30–110	150–265	300–500	720–1240	16	4	20.0
Altoona, Pa................	10	38	90	......	4800	30	90	Yes	Yes	30	100–120	500–600	1000–1030	2000–2240	18	Elec.	......
Enola, Pa................E.	7	50	33	68	3800	25	......	Yes	No	......	......	....	1318	2151	7	....	10.0
Enola, Pa...............W.	9	45	38	68	3800	29	......	Yes	No	......	......	....	1396	2488	7	....	10.0
Conway, Pa..............E.	12	45	25	55	3500	20	5	Yes	Yes	300	63–90	295–425	550–810	1060–1450	20	8	18.0
Rutherford, Pa.............	5	44	30	44	2500	29	0.5	No	......	......	150	600	900	1500	17	7	......
Hazleton, Pa..............	5	65	22	45	3350	25	......	......	......	......	70–100	350–500	700–1000	1400–2000	7	16	9.0
Asheville, N. C............	4	30	20	30	1200	15	10	Yes	Yes	50	80	400	800	1000	5	5	5.0
E. St. Louis, Mo...........	3	40	25	25	500	12	......	......	......	......	100	500	1000	....	7	5	10.0
Terre Haute, Ind...........	12	19	......	30	1000	12	10	Yes	Yes	30	......	....	....	....	8	....	8.0
Alexandria, Va...........N.	5	22	32	20	840	15	20	Yes	No	......	......	....	....	....	7	....	32.0
Alexandria, Va...........S.	7	21	29	20	520	14	0.5	Yes	No	......	......	....	....	....	6	....	32.0

A record in a number of hump yards shows that the time consumed in switching is from one-fourth to one-third of the total time; and the time in disposing of one car ranges from 54 to 111 seconds, depending largely on the distance of the classification yard switches from the hump, the rate of grade, the kind of cars and lading, and weather conditions.

One road operating many hump yards has a rule that the speed at impact between cars must not exceed 2 miles an hour, and that in classifying, cars must be ridden home when necessary to obtain this result.

The Pennsylvania recently installed two electric search-lights in its Harrisburg classification yards, to facilitate the distribution of cars in incoming trains. The westbound classification yard at Altoona has one very powerful electric search-light which affords adequate illumination at the extreme end of the longest classification track. The light is operated from the tower and its rays are directed with the movement of traffic and therefore on the back of the car riders.

CHAPTER VII

THE YARDMASTER

The yardmaster leads an eventful life. Receiving, sorting and dispatching large numbers of small parcels without error require alertness and accuracy. The yardmaster must have these qualities, but when, for parcels, we substitute huge, complicated vehicles, occasionally broken and always breakable, coming in irregular flow and numbered by thousands, the yardmaster needs to be something more than a parcel-handler. Every unusual incident hinders him, nothing helps him, for his work is movement, his danger is blockade. It is quite unlike the work of the engineman, because the yardmaster cannot make the movement approximate uniformity, nor can he personally perform the work; he must depend upon fallible mankind. Cars come to him in bunches to be unloaded, or sorted into new trains, or to be repaired and sent forward—for his bailiwick is simply a part of the main line movement, slightly expanded for his purposes of breaking up and marshalling trains.

A good yard is as nothing if not kept in condition to perform properly the service required of it. A blockaded yard means a blocked road, an absolutely useless, expensive tool; and this can be brought about in a day, not necessarily by doing the wrong thing, but by the yardmaster not doing enough. In times of emergency, to err on the side of safety does not mean, as in many other kinds of work, to watch and wait. Delay is often fatal. The yardmaster must do something vigorously, even if it be far from the best thing, and he must keep on going without admitting, for a moment, an impossibility. The ideal man for this work should have an aptitude and ingenuity for meeting small and great emergencies, quite beyond the ability to follow rules. He must be resourceful. In a big terminal the difference in value between a good yardmaster and a poor one may amount to a president's salary.

Many yardmasters are retained because they are not well watched. Their highly expensive operations may be lower than those of other yards, although the other yards may be handled more successfully. Apparent success in one yard may be due to congestion existing in other more difficult or crowded yards which are attracting attention, or to the erroneous assumption that yards not complained of are well handled.

The yardmaster who is competent to handle a difficult situation is not always estimated at his full value. This may be due to superficial criticism by chief clerks, and others in the offices of the superintendent or general superintendent who may be without practical experience. Their superiors are busy and the yardmaster may lack the time or educational training necessary to convince. An awkward location, want of facilities, unadaptable motive power, insufficient wages paid to secure competent or reliable help, bad make-up of trains approaching the yard, and requirements as to make-up of outgoing trains—these are among the conditions that occasionally give the good yardmaster a bad name.

The question was asked a well-known transportation officer: "What kind of a man does it require to satisfactorily run a big yard?" The reply was "The kind of a man who can run this United States Government." The ability to do things can hardly be overestimated. It is better to risk censure for doing something than for doing nothing. When a washout, snow-blockade or other obstruction closes the line and cuts off communication, it is gratifying to discover afterward that somebody took the responsibility to start relief trains and get things moving—that somebody did something. There are men of the other stamp who do nothing unless directed and who have to be told everything and then do but a part of what they are required to do. They are comparable with the engineman who wires the dispatcher that his engine is disabled and asks what he shall do about it.

The greatest difficulty in securing competent help and in honest, capable workers securing positions of trust, exists in the very limited number of persons who may be known intimately by anyone employing others in positions of responsibility. Many are in need of faithful and efficient help; many deserving workers need employment. While awaiting a train at a point where it stopped to take on a dining-car at the foot of an Allegheny Mountain grade one cold winter's morning, the writer was impressed with this fact in observing the actions of a man known as "Jim" to his fellow-workers. Jim was the pumper at a salary of $45 per month. His regular duty was to run the pump and look after the unloading of coal for use on the helping engines. One of the helping engines took the dining-car from a siding and brought it across the two main tracks to attach it to the rear of the eastbound passenger train. Jim left his pump, made the couplings between the engine and dining-car, gave signals and went up into the interlocking tower several times to coach the relief signalman who had not been there very long and did not understand the levers. The engineman and fireman made no move to do anything outside of their regular work; the signalman was incompetent to do his own work and made no move outside of that. Jim alone did things and kept everything going. He was a young man who had worked at that place and in that same position for years and was never heard from because he did things right and corrected mistakes of others. The engineman, the fireman, and the signalman, doubtless, called on the division officers frequently to explain delays, failures or to present "grievances." Jim was worth more than all of the others, but he was kept out of the more responsible and remunerative position he deserved because the officers did not know him intimately or lacked the moral courage to change anything at the little mountain station that might cause them some slight, temporary inconvenience.

To gain and hold the support of his men the yardmaster must have their confidence and respect. This will be given him if he is a man of good character and knows his business. Respect is not accorded a man who is incompetent. In manner he should be quiet and unassuming, but in conduct just and firm. He is assumed to have been one of the men with whom he works. He should continue to associate with them sufficiently to know them thoroughly, while preserving the necessary amount of dignity to prevent even an intimation of favoritism.

A successful yardmaster in a difficult yard had been advanced from the position of freight conductor. While in charge of a train he had the draft timbers pulled out of the front end of a refrigerator car loaded with fresh meat. It was impossible to chain up or replace the drawhead. Trains were not frequent, it was a long distance to the terminal and shops, and the business was highly competitive. The conductor made his plans and immediate action followed. He pushed the car and part of his train back to the next spur track in the rear. The brake rigging was disconnected, one truck of the car was run down the main track and the other truck on the spur. The trucks were worked back in this way until the car body stood at right angles to the main track. The truck on the main track was then worked forward. This turned the car, end for end, after which it was coupled to the rear of the train and moved to its destination. That this man was selected from a large number of employees to fill the responsible position of yardmaster in a heavy terminal does not seem surprising. The way in which the trouble was met and overcome is characteristic of the man who is full of resourcefulness and prepared to meet any emergency.

Because yard- and roadmen are usually kept in separate classes by wage schedules and seniority lists, and because they perform a different character of work, a road brakeman seldom makes a good switchman and, as a rule, a road conductor makes a poor yardmaster. Yardmen, by reason of their training, fill the position better. A road engineman is usually of little use on a yard engine. Road- and yardmen are sometimes used interchangeably, and the work is done, yet few managers know the ultimate cost of this method.

When the position of yardmaster has been satisfactorily filled things move smoothly. When or how this is done is not apparent to the casual observer. Good yardmasters do things. They do not usually tell much about what was done or the manner in which it was done. This is unfortunate because many of their "shop kinks" are valuable and they would make interesting and instructive reading. In numerous details they make themselves felt and only their close associates know how it was done. There was a case not long ago where a yardmaster who knew his business supplanted another who was supposed to be a first-class yardmaster and whose yard was being handled without criticism. It was not so badly congested nor as expensively handled as some others. The new yardmaster decided there were more men accompanying the engines than seemed necessary. It was explained to him that curves and certain obstructions made it necessary to have one man to pass or repeat signals. He had several of the engines turned around enabling the engineman to take signals direct. In this manner without detriment to service, he was able to take one brakeman off each of five engines. As these men were paid $2.40 per day this resulted in a saving of $12 per day or $4380 per year. The reader will probably ask why it did not occur to some one to make this slight and insignificant change by which the new yardmaster saved double his salary. These little things which should be apparent to everyone are the ones which often pass unnoticed.

In another case an engine was compelled to work headed toward a coal-storage plant on the approach grade, placing the engineman on the outside of a curve and on the side opposite that from which the switching was done. It was necessary to repeat signals through the fireman, and, as a result, detentions and accidents occurred. At an expense of a few dollars the engine was made left-handed, that is to say, the throttle, reverse lever, air-brake valve, etc., were placed on the left or the fireman's side. The engineman, thereafter, rode on the left side and took the signals direct. The saving of one brakeman's wages was effected and the amount lost in accidents materially reduced. A simple move and one anybody could have made, yet nobody thought of it.

In many instances money may be saved by connecting up near-by switches to distant levers through the use of pipe lines, enabling one switch-tender to cover the work of two or more. The use of spring switches on inside tracks where movements are normally in one direction, has already been referred to (Chapter IV,) and is among the many devices that may be utilized to increase efficiency and reduce operating costs.

A superintendent whose engines ran into and were turned in the terminal at one end of the adjoining superintendent's division, complained bitterly of the detention to his engines in the terminal. The yardmaster spent much time in explaining why the engines could not be returned more promptly and in this way the stereotyped complaints and explanations mechanically followed each other. The superintendent in charge of the terminal, tired of this unproductive work, and made an investigation in person. After a careful analysis he found that about one-half of the cars in the trains coming in with engines to be turned were destined to the next division terminal beyond, while about the same number of engines that were not to be turned had about half their cars for the first terminal. In other words the through and "turn-back" trains and their engines were being badly delayed because of the switching work made necessary by the neglect of the yardmaster at the last division terminal back, and for which the complaining superintendent was responsible. There is nothing to be said in defense of the yardmaster who had not the intelligence or interest in his work to inform himself as to existing conditions instead of writing letters explaining his own shortcomings. This may serve to illustrate the difference between two types of yardmasters—the broad gage and the narrow gage. This yardmaster worked in a rut and seemed unable to lift himself out of it without assistance.

While in charge of a busy terminal yard where 12 or 14 switching engines were working at one time the writer devised a plan to avoid the loss of time by each engine and crew of from five to seven men while the engine was run to and from the engine-house to have fires cleaned, and take coal, water and sand, or to have minor repairs made. Delays on these accounts usually occur when the engine is most needed, and they are a source of annoyance to the yardmaster and expense to the company. A relief engine was put in service, manned by a hostler and a helper. It started out in the morning following a regular schedule in going to one engine, taking it back to the ash-pit while leaving the relief engine for the regular crew to work with, returning the yard engine to its crew and then moving on to relieve the next engine. One engine and crew were dispensed with in this way and the remaining engines and crews were kept moving continuously at the cost of one hostler and helper. This plan is still carried out in the yard referred to.

The writer was once told by a yardmaster in a busy switching yard where much placing of cars had to be done for local industries on crooked and steep-grade tracks, that in the face of enormous opposition he reduced the number of men in each switching crew by one man. It was claimed that the work could not possibly be done and that accidents would increase in number and extent. After a test of 1 year his accident account was found to have been reduced 30 per cent., while an increased amount of business was handled without additional engines. The accuracy of these figures is not vouched for, although there is no reason to question his statement. One can readily see how such a result might be attained. In a measure it reflects on the discipline of the yard under the previous management. This is in line with the reasons given by the roads operating wide fire-box engines as to why an additional man should not be placed on engines to take the engineman's place in case he dies of heart disease. They argued that instead of securing additonal safety the opposite would probably result, as the two men would spend much of the time "visiting" and nobody would be on the look-out.

In a certain yard an engine was required to take care of one of the freight-houses and as well do certain yard work in a large city and at the near-by coal pockets. During the fall and winter months when general freight required much attention the coal would run heavier and it required several hours' work of the engine each morning to push the loaded coal cars to the foot of the approach to the coal trestle. They were then hauled to the top by a cable on a drum, operated by a stationary engine. From the top of the incline the loaded cars were dropped by gravity over the various pockets and then by gravity over a switchback arrangement to the empty-car track, on which they were returned to a track alongside the starting track. This method had been followed for years; in fact since the coal pier was built. It had never occurred to anyone that an improvement could be made. The yard engine's inability to do all its work and the fact that the freight platform was being neglected, notwithstanding the men worked overtime, did not start a train of thought anywhere. But when an old hoisting engine. found in one of the scrap piles, was connected up to the stationary engine boiler at the foot of the incline, at a total expense of not exceeding $100, 30 or more loaded coal cars, or enough for the heaviest day's work, were placed on the approach tracks at one operation, and from thence were reached by a cable and drawn, by the stationary engine, to the foot of the incline. No additional men were needed at the coal pier and several hours' time was saved each day for the busy yard engine, a saving amunting to more than $200 a month.

Close scrutiny of the work at a transfer station, a manufacturing plant, a shop yard or other "side issue" may develop a feasible and advantageous change in the manner of doing it. A consolidation with other work will sometimes make possible a saving of half a day's work for an engine. A slight change in the track lay-out or the addition of a switch or two in the yard of some private industry may make possible a reduction in engine service. Because a reliable conductor has been following up the work in a district for years it must not be assumed that he would see all the possibilities for improvement. He may be conscientious enough to tell about it if he saw it; he is nevertheless liable to fall into and remain in a rut. Men are creatures of habit. A condition may to-day be noted in yard operating that seems, and is, entirely irregular or improper. For some reason it cannot be got at immediately and is permitted to exist for a time. After seeing it day by day for some weeks it begins to grate less harshly on the nerves and after awhile does not attract one's attention. This is something to be avoided. It becomes a habit or custom to do yard switching at outlying points at a certain time of day. It may be done more advantageously at some other time. A different hour may benefit the work at another point.

Frequent interviews with the managers of manufacturing plants and other industries requiring special switching service, will often suggest a plan whereby work may be cut out to the mutual benefit of both corporations. Aside from this, however, such interviews usually do good by enabling the yardmaster to keep in close touch with the road's patrons and learn of objections to, or irregularities in, the method of doing switching before they assume the proportions of a formal complaint. The manager of an industry is encouraged to state his wants direct to the yardmaster, thereby securing the quickest and most satisfactory result, and he may give the yardmaster valuable suggestions.

The congested or blocked yard will happen occasionally. No general plan of action can be formulated to successfully cope with this trouble. The first attention should be directed to the inward movement with a view to stopping or reducing it. The demands and threats of shippers and the traffic officers should not be permitted to influence other action; they themselves will be the greatest sufferers if heroic measures are not adopted and faithfully executed. Switching room is as essential in a yard as is an open main track for train movements. The incoming freight may be stopped by placing a general embargo, by sidetracking on the home road, or in such other manner as may be determined under the conditions existing. After the disease has been diagnosed its cause should be removed. If this is lack of power or improper handling of power on a connecting division, that difficulty needs attention. A foreign connecting road may not be moving its cars because of indifference or inability; a large industry may not be unloading promptly or may be receiving more material than it can handle. Be that as it may, the cause of the blockade should be quickly eliminated. Sufficient forces may not be provided to take out as many cars as are brought in. This can result in but one thing, and it is only a question of time when the blockade is on.

The blockade troubles may be aggravated by the action of a weak yardmaster who is overawed by a chief train-dispatcher and permits one of his main tracks to be blocked. After this track is filled—whether a single track or one of two double tracks—the yard is in worse condition than it was before. It has the additional handicap of reduced switching-room and increased attention necessary on the part of the organization to care for main-line trains, while it is in no better shape in the matter of moving cars. When confronted with a blocked yard, no attempt should be made to single out preferred or special delivery cars on urgent requests from anybody. As this stand is taken solely in the company's interest and for the benefit of its patrons, it should be indorsed by everybody from the trainmaster to the president. If the congestion is serious, the efforts of the yardmaster to single out a few cars scattered here and there, instead of taking all in their turn, may cause the condition to continue for months, or until relieved by a gradual reduction in business handled. If, on the other hand, he ignores the special or preferred car orders he may succeed in relieving the blockade in a comparatively short time. It requires some nerve on the part of a freight agent to decline to order a car placed immediately for a consignee who presents a bill-of-lading showing that it is already some two weeks overdue, and who can point to his car standing on a certain track in the yard, accompanying his request with harrowing tales of suffering, loss of business, prospective damage claims, etc. It requires even more nerve for the higher traffic or operating officers to maintain the same position. The point that is not usually explained and which cannot always be accurately demonstrated is that in all probability 99 cars are delayed as a result of giving, or attempting to give, preferred attention to one car.

The evil of the "hold car" is another obstacle in the way of opening a blocked yard. Where few hold cars are handled, or where ample facilities are provided to care for them, the evil may not be a serious one; other things being equal, the annoyance becomes more far-reaching as the number of hold cars increases and the average time of enforced detention lengthens. While it is generally assumed that the term "hold cars" embraces only such as are detained for traffic reasons, cars held for any purpose, as awaiting entrance to shops, empties held for loads or orders for distribution, embargoed cars, etc., will produce the same effect.

The usual move made, when a blockade threatens, is to put away trains or cars in any tracks that may be convenient in order to tide over the difficulty temporarily without regard to the hereafter. These tracks may be convenient to get into but are usually difficult to get out of. The cars are then overlooked and lost; in any event they cause more trouble afterward by reason of their getting into the wrong place. These and other temporary makeshifts should be avoided. A well-regulated yard, like a well-ordered house, has a place for everything, and everything should be kept in its place. To vary from this practice is sure to cause trouble. The car that finds its way into the wrong and unusual track is a trouble-breeder, and will probably cause enough loss of the time of engines and men to handle several hundred cars that were run into the right tracks.

The yardmaster who, in person or through his assistants, keeps a close check on the cars standing last on single end tracks—that is to say, the cars farthest from the switch or connected end of the track—and does not permit them to stagnate, will ordinarily keep things moving. Double-end tracks seldom have "ancient" cars on them. When they do, it is an indication of extreme indifference of employees or inadequacy of facilities.

There is no detail in handling which is more exasperating than the attempt to locate responsibility for accidents when engines back or push cars and permit them to strike too hard. The engineman usually sees no stop signal; the trainmen gave it in ample time but it was not obeyed. An excellent rule is one requiring an engineman to consider the disappearance of hand signals when pushing cars ahead of engine as a stop signal. This practice will avoid many controversies.

The yardmaster, like the general in command of an army, must, above all things, retain his composure and control his temper. The worst effect of his failure to do this is in its result in the work of his subordinates. "Like master like man." Little can be expected of men during disturbing times when they see their leader become "rattled" and going about in an excited manner talking and gesticulating wildly. The habit of suppressing any visible signs of emotion or chagrin may be difficult to acquire, but it is one that should be cultivated.

The yardmaster in charge of a terminal should have the authority to make minor changes and not be compelled to go to someone higher in authority for approval of them. If he is not competent to exercise this authority he is not the man for the position, but if he is capable he may be so handicapped by instructions regarding details, as to render his administration a failure. The nature of the work often requires quick, intelligent and positive action. If more engines are needed, or additional men with certain engines, he should put them on and not be required to waste emergency time in asking authority to do so and making explanations. Conditions frequently arise where a delay of a few hours or even a few minutes may cost much more than the expense of preventing it. A sluggish road movement may be followed suddenly by a heavy run into the terminal. A derailment in the terminal may create a condition necessitating help in a certain district, to enable other parts of the machinery of the terminal to keep up speed. Failure to supply the necessary help with men or engines may cause a complete cessation of work through the clogging of one part. The yardmaster should be allowed to act in emergencies and explain later. If he has not the capacity, he should be gotten rid of.

A certain terminal was badly congested in the early winter, through a penny-wise, pound-foolish policy. On account of the constant heavy run of freight this terminal was not cleared until the following spring when there was a considerable decrease in the freight movement. In this case the yardmaster and the trainmaster were wide-awake. They had fully appreciated the situation and anticipated the condition approaching them, but were not empowered to act. For every dollar they wanted to spend to keep things moving, the company afterward spent five-hundred. In this were included heavy claims paid for freight damage by detention.

The reader doubtless knows of similar instances; in any event, he has read of many cases in the newspapers during the last few years, of congestions in big terminals, that seem to indicate incompetent terminal managers. It is convenient to charge it up, in the newspapers, to "abnormally heavy traffic." Somebody should have seen it coming and received it with guns loaded.

The manager of the terminal, the yardmaster, must have his organization in such shape as to require but a small proportion of his time to be spent indoors. He should have a free hand to come and go at will, and occupy his mind with the larger and broader proposition while not overlooking the smaller. It is his duty, and during the season when his yard is heavily taxed, his salvation to know all he can possibly learn in advance of heavy and unusual train movements, to prevent his being caught in a state of unpreparedness. As to how far ahead he should look for heavy traffic movements, he should look as far as he can see and farther. This Hibernicism means that he should get information from those who have the means of knowing more than he does of the probable amount of freight traffic to be handled. The men at the head of the traffic department are always well informed on these matters. Their representatives are scattered over all parts of the country and are required to made reports to the general officers, in whose offices it is conveniently tabulated. Frequent conferences with the traffic officers should secure much information as to amount, kind and direction of anticipated traffic. While something of this kind is usually done, the writer knows of no road where it is gone into as thoroughly as it should be.

The yardmaster should know when his organization is perfectly balanced and keep it so by making the necessary adjustments as needed. The terminal system or "cluster" is usually divided into sub-yards or districts. It is the practice to put one or more engines into each district. Satisfactory service follows when an engine, with its crew, is kept in the same work. Because of the comfortable, easy working of this method, an engine is often continued in its district, although the business may have decreased one-half, or the engine in the classification yard may be unable to keep up with its work, while the engine in the shop-yard, or at the transfer platform may have enough spare time to assist the former. Sometimes the work may be facilitated and the necessity for additional engines obviated by adding one or more car-checkers, brakemen, switch-tenders or car-riders. It can be readily figured out how many men may be added before reaching the cost of an engine and its crew.

Through the follies of red-tape or the employment of men in whom no confidence is felt, it is occasionally left to the yardmaster to add engines and crews, as he deems necessary, while to get an additional car-checker he is compelled to go to Rome and back again. He has to make out an application which passes through the hands and requires the approval in turn of the trainmaster, the superintendent, the superintendent of transportation, the general superintendent, the general manager and in some cases finally—after passing one or more vice-presidents or assistants or assistants *to*—reaches the president. After all approvals have been regularly affixed, the return trip is made through the same channels. This because the car-checker comes under the head of "fixed force." By the time the yardmaster gets his authority for the employment of the car-checker the necessity for the additional help may have passed. It is therefore no cause for wonder if instead of asking for the assistance of the man to tide him over the impending crisis of a heavy run of freight, or of bad weather tomorrow or possibly to-night, or even to-day, he calls for the engine with its five or six men. He adds an expense of something like $25 instead of $2 or $2.50.

This preponderence of machinery works loss in another direction: A yardmaster knows he can dispense with the service of one or more clerks, checkers, switch-tenders or others of the "fixed force" as the business eases off, in the spring presumably, but that he will again require this help in the autumn, and probably on short notice. He has also learned from experience that it will take a long time to get his applications through. It is not surprising then that he makes up his mind that "a bird in the hand is worth two in the bush," so he keeps the useless men on the pay roll all summer.

Much interest was manifested in a recent discussion on "team work in railroading." Team work is nowhere more needed than in a railroad terminal. The most capable yardmaster cannot succeed without the co-operation of his fellow workers. The spirit of "the company for all; all for the company" is as essential to the success of a railroad as the rails upon which its traffic moves. Organization, co-ordination, and system are indispensible to efficient terminal operation.

Abraham Lincoln said:

> "When people saw Stephen and Franklin and Roger and James, each working independently, as they proclaimed, turning out mortised timbers which fitted perfectly together to complete the framework of a house, with not a stick wanting and not a stick superfluous, it was natural to conclude that Stephen and Franklin and Roger and James were operating according to a common plan."

CHAPTER VIII

MANAGEMENT AND DISCIPLINE

Among the many perplexing problems of railroad management, none are more important or more difficult to solve satisfactorily than those of organization and discipline. One has but to note the many forms of organization and methods of discipline on American and foreign railroads to see how authorities differ in their estimate of the essential or desirable. On one point, however, there is little difference of opinion. All agree that the *sine qua non* of discipline is constant and unremitting vigilance on the part of those charged with the duty of supervision. No system will take the place of it; no system will succeed without it.

It is not the purpose of this book to deal with the moot questions of organization, that is, to go into the arguments for and against the divisional type or the departmental type. The Pennsylvania road is the best example of the divisional plan; the New York Central is a good example of the departmental plan. On the Pennsylvania the operating unit is the division, and the division superintendent is in complete charge of all its operating activities. Not only does he control station operation and train movement, but to him report the division officers of the maintenance of way and maintenance of equipment departments, except in technical questions of design and standard practice which are decided by staff officers reporting to the higher operating officers. Thus, the superintendent is supreme on his division. Under the departmental plan, the operating unit is the department. The division superintendent has direct control only over the transportation department—the operation of stations, yards and trains—and has no jurisdiction over the maintenance of roadway and the maintenance of equipment. In charge of the roadway, the division engineer reports to a chief engineer instead of to the superintendent; in charge of motive power and car maintenance, the division master mechanic reports direct to the superintendent of motive power. The lines of authority and responsibility under the departmental plan do not converge short of the general manager; under the divisional plan, they converge in the division superintendent.

The departmental form of organization has its highest development in England, and it may be said to be the general plan for all railways outside of the United States. Yet it can hardly be said that American railroads are typically of the divisional type. Many cling to the departmental form, but the tendency is strongly toward the divisional. Several roads have a type of organization which is neither one nor the other. The

Santa Fe, for instance, gives its superintendents jurisdiction over track, but leaves the maintenance of equipment to the master mechanics and the higher officers of the motive-power department. The Frisco Lines have recently changed from an organization of that type to the straight divisional plan. On the New York Central, the tendency is to strengthen the superintendent by giving him more voice in affairs of maintenance, but his authority is not definite nor indicated by the organization chart.

The most recent development in railroad organization is the adoption of Major Charles DeLano Hine's "Unit System" by the Harriman Lines. It was first made effective in 1908 on a few divisions of the Union Pacific and has gradually been introduced on every division of all the 18,600 miles of the Harriman Lines, with their 80,000 employees. It is a high development of the divisional plan and the "unit" of authority is the division superintendent.

The Unit System can best be described by quoting from Major Hine's writings on the subject. Touching first on some of the defects in the common form of organization he says:

> "The most difficult task in any organization of human endeavor, is to correlate the activities of the workers on the outside with the necessary requirements of correspondence, records and accounting on the inside. The artisan in the shop, the traveling salesman on the road, the soldier in the field, the sailor at sea, the railway man on the line, all have their troubles with the man in the office. When the inside man knows the outside game at first hand such differences in points of view are minimized, friction avoided and therefore money saved. Railway operation is the most exacting of human tasks. Like the conduct of a household, a farm, a hotel or ship, it is a continuous performance. Unlike those exacting occupations, it must maintain its own communications over hundreds or thousands of miles of territory. So complex is its administration that chances should not be taken of losing money through half-baked decisions of partially trained office occupants. Most railway officials flatter themselves that when on the line they maintain a grasp on the office, yet every hour in their absence action must be taken on matters which, apparently trivial in themselves, have far-reaching results. This statement is not a reflection upon the splendid ability and earnestness of railway officers; it is merely a recognition of the fact that a man can be in only one place at a time; that there are only 24 hours in the day and only 365 days in the year. The salary of one officer is negligible as a percentage of the operating cost of the average unit. Accordingly the system insists that the second best man of the unit, with practical outside training, shall stay at headquarters and sit on the lid. In some cases it has been found necessary to appoint another official to perform the previous outside duties of the senior assistant. In other cases it has been found that the outside work could be divided up among other members of the staff. . . . . . A railway harnesses the forces of nature, including its divinely human elements, for one purpose—the manufacture and sale of an intangible commodity—transportation. The more closely interwoven the constituent parts of production, the more efficient and

economical should be the output. When weaknesses develop, when education is needed as to the increased importance of a given element, the remedy is not necessarily the creation of a separate department."

Major Hine then explains his remedy. Briefly it is to consolidate all the subordinate offices on the division with that of the superintendent; substitute an experienced outside man for the chief clerk to represent the superintendent when the latter is on the road; and breakdown departmental lines by abolishing the titles of the trainmaster, master mechanic, division engineer, road foreman of engines, chief train-dispatcher and division storekeeper and in each case substituting the indistinctive title of "assistant superintendent," giving each officer equal authority in all departments but assigning each to his former specialized work as his prime duty. The underlying principle is to broaden these men out beyond their departmental limitation and afford them a training which will fit them better for promotion to positions of greater responsibility. The system forces men to assume responsibility and as Major Hine tersely puts it, by so much increases the protection to the company's interests. More is heard about 'this division' and 'the company' and less and less about 'my department'. . . . . "Formerly, office-work was grouped around officials. This resulted in petty principalities and bureaucratic administration. By tearing down some office partitions there were razed those figurative department walls which so often operate to keep in the man who is trying to keep the other fellow out. Under the new conception the work is grouped by classes. The technical term among business experts is 'the concentration and co-ordination of routine and related processes.' "

The methods of discipline in effect on American railways may be summarized under three headings:

(1) Discipline by suspension from duty with loss of pay.
(2) Discipline by record—the Brown system.
(3) Discipline by both actual and record suspension—a combination of (1) and (2).

Under all three plans, certain capital offenses call for summary dismissal from the service.

Mr. George R. Brown, while General Superintendent of the Fall Brook Railroad, nearly 30 years ago formulated and applied what is known as the "Brown system of "discipline without suspension," or punishment without loss of pay. *Actual suspension* means laying an employee off for a period of from 5 to 60 or even 90 days, for which he receives no compensation. A *record suspension* is an entry of a certain number of days (or demerits counts) on the employee's record, while he continues work and receives compensation. The *record* suspension in days or demerits counts is ordinarily the same as would be the number of days *actual* suspension under the old system. When an employee's record days, or demerits counts, reach a certain number—usually 100—he is dismissed.

The Brown system was new in detail only, for some of its important features had previously been tried on the Pennsylvania. The essential features of this system are keeping a record of an employee's irregularities in the performance of his service as well as of acts of special merit, and posting bulletins containing brief accounts of the incidents, causes and lessons connected with each record entry.

Many roads use the Brown system in a modified form. Some use the "record suspension" for every offense, except for cases meriting dismissal; others use record or actual suspension according to the merits of the case or the general character of the offending employee; while others again, use only the bulletin feature. There are varying opinions as to the real benefits to be derived from the record suspension feature and the effect depends largely on the class of men employed. There is, however, a general belief in the beneficial effects of bulletining a history of each offense. It is especially desirable in unusual cases and in instances where ordinary rules are being violated. This has the effect of warning employees without resorting to objectionable practice of issuing a notice calling attention to the necessity of observing a certain rule, thereby implying that other rules are of less importance.

Take the case of a flagman who is disciplined for not going back a sufficient distance to protect the rear end of his train. Under the old system, when the facts in the case were not officially promulgated, his disposition would be to misrepresent to his fellow-workers the actual cause of his suspension and he would make the case look as favorable to himself as possible while correspondingly reflecting on the judgment or ability of the officer directly responsible for inflicting the discipline. The impression is naturally created that the officer is despotic, or unfair, and that the employee has been imposed upon. Such impressions have the effect of creating bad feeling, particularly among the lower classes of employees. The bulletining with the Brown system changes this and is the strongest point in its favor.

One modification of the Brown system embraces a record book in which two pages are devoted to each employee; one for the debit and the other for the credit side. The usual entries, covering the employee's age, height, color of hair, eyes, weight, date of service and of various changes or promotions, are made at the top of the page in blank spaces provided for that purpose. For each offense requiring disciplinary action the employee is charged with a certain number of demerit marks, or nominal days of suspension, and for acts of special merit he is credited with merit marks, or days, which, in some cases are allowed to cancel a like number of demerits or days of suspension on the opposite page. A bad record is followed by dismissal, while a clean record for a given length of time, say, three months, six months or a year, usually entitles the employee to a certain number of merit marks, or cancels a certain number of demerit marks. All roads continue to apply the penalty of dismissal to cover cases of intoxication, insubordination and other extreme offenses.

When a record is entered, on either the debit or credit side of the book, a bulletin is issued containing a brief history of the case and is posted on the bulletin boards at designated points. Locations, names of men, dates, and train numbers, are omitted for the purpose of avoiding attack by agitators and to prevent undue embarrassment to sensitive employees. For similar reasons and to avoid controversy or comparisons the extent of discipline is sometimes omitted. It is customary, too, on some lines to give the actual or estimated amount of damage done where damage results.

The following is an example of a bulletin taken from actual practice:

> "A freight conductor and flagman have been disciplined for failure to properly protect their train while it was stopped at a point on the main track. The explanation made by these men was that it being daylight, with a good view to the rear, it was deemed unnecessary for the flagman to go back farther than he did. A flagman employed for the purpose and out the required distance will doubtless succeed in attracting the attention of an engineman who may be working on the injectors or watching the water gages, and may also arouse him if he has for the moment dropped off to sleep. Leaving out the question of the engineman's neglect of duty in the case, the flagman's attention to duty may prevent a serious accident and possible loss of life."

Another example from a bulletin is the following:

> "By throwing the wrong switch in a divisional yard, a switch-tender caused cars to 'corner' on a frog resulting in damage to the extent of $1690 and for his negligence has been disciplined. The investigation developed that he was engaged in conversation with a car rider, and as a result started for the switch too late and became confused because of the short time he had to clear the car. Yard employees, and particularly switch-tenders, need to have their wits about them and their minds on their work while on duty. They cannot properly perform their work when engaged in outside occupation, or 'visiting' or when they come on duty without good, clear heads due to insufficient sleep or use of intoxicants during the hours they have been off duty."

It is the usual custom, where book records of employees are kept to permit an employee to look at his own record at any time, but he may not look at the record of any other employee.

One of the strongest arguments in favor of discipline without loss of pay is the prevention of suffering to the family of the employee. During an actual suspension, the loss of pay entails undue hardship upon innocent women and children. To an employee with a conscience the thought of pangs of hunger which are causing suffering to his wife and children, due possibly, to a miscalculation or error in judgment on his part during a brief moment while working perhaps with the best intentions, may permanently cloud his efficiency; it certainly does not tend to make him a better man or to engender in him any strong feeling of loyalty or regard for his superior officers or the company.

Every railroad has its busy and dull season during each calendar year. There is a time each year when it is unable to give its men sufficient employment and another season when it is unable to secure a sufficient number of competent men to perform its work. During this season of heavy traffic, in many sections accompanied by unfavorable weather, trainmasters, yardmasters, and others are inclined to overwork their men, rather than employ a number of "green" men. The strain due to density of train movement and overloading of cars develops all weaknesses in locomotive power. The liability of men to make mistakes and cause accidents is correspondingly increased. Under the older systems of discipline, the suspension of the trained and experienced employees would then begin, followed necessarily by the employment of inexperienced men. The number of accidents and failures of various kinds then further increases. Under the system of nominal suspension this difficulty is done away with while the record kept still enables the value of the employee to be ascertained and the educational features are not lost.

On the general subject of discipline, Mr. Brown says:

> "It often occurs that the disgrace and injury occasioned by a strict enforcement of a sentence does more to ruin the guilty than anything else, and a wise provision has been made allowing courts to use their judgment as to carrying out punishments; this is known as 'suspending sentence.' If the sometime offender does better, and is not guilty of the same or other offenses, the judge conveniently forgets the indictment hanging over him, but should he go on committing one misdemeanor after another, his record rises up to condemn him. I believe in the practice of 'suspending sentence' with railroad employees.
>
> "With this system the good men are retained, developed, benefited and encouraged, and the culls are got rid of to the betterment of the service all around. Every wreck, every accident, every mistake, every loss has taught its lesson, and these are of no less value to the railroads and to the railroad men than the successes. I practice making every mishap a lesson to every man on the road. It often happens that an accident, or a close shave for one, is the best kind of a lesson to the man who could be blamed; and if he is retained in the service, he is a more valuable man than he would otherwise be or one who could be hired to take his place."

The Brown system of discipline is incomplete without the accompaniment of the credit or merit feature, but this is dangerous unless cautiously handled. Shall we bulletin or reward every meritorious act, or where shall we draw the line? The writer recalls an instance where a passenger-train flagman went back and remained out several hours in a rain storm, damaging his new uniform. The trainmaster secured the approval of his superintendent for the purchase of a new uniform. A generous act, certainly, but with disturbing results. Why should an employee be specially rewarded for doing his duty? Why should not the passenger-train or freight-train flagman provide himself with a rain coat and rubber shoes, and have them at hand during rainy weather? For a time other passenger flagmen, who had to go back, during a drizzling rain, or while the dew fell heavily, asked for new uniforms. They were highly indignant when their requests were not granted. It is difficult to draw the line accurately between special merit and duty. The danger does not exist in rewarding one employee, but in the fact that always there are many who are not rewarded though equally entitled to special recognition.

A flagman hanging out of a caboose cupola, saw a broken rail on the opposite track and signalled a fast passenger train preventing it, by quick work, from running over the broken rail and possibly from being derailed. He received a number of credit marks. It was his duty after he discovered the break to notify the passenger train; he had done just what any employee should have done. It was not his duty to look at the rails on the opposite track; he was evidently doing it in a dreamy indifferent way. While looking at the rails of the other track he was not watching his own train, to detect heating journals, break-in-twos, loose car doors, etc., and it was his duty to do this. Incidentally it may be added that this flagman was dismissed some six months later for being intoxicated while on duty.

An engine ran away from a hostler, and got out on the main track, running the wrong track, *i.e.*, against the current of traffic. A switchtender promptly notified a yard engineman, who got his engine out and overtook the runaway. He climbed over the pilot of his engine, reached the cab of the runaway, shut off the steam and stopped it. This engineman took some risk, but he received no credit marks. The speed was low, the actual risk taken was probably no greater there than he incurred every night in his regular yard work and his action was considered as being in line with duty.

One of the common, if not the most common error made in disciplining employees is that of considering the result or effects of a violation of rules or instructions instead of the actual offense. Trainmasters often inflict comparatively light discipline on a flagman who does not go back a sufficient distance to protect his train, provided no damage has resulted. But few trainmasters would let a flagman off short of dismissal if his failure to go back the prescribed distance resulted in several thousand dollars' damage, loss of life and a badly blocked railroad. Is this not because the reports in the case with disastrous results will be carefully read and considered by those high in authority? But is the effect on the service desirable?

Of the large number of men in positions of authority,. who fully understand what is to be done and how it should be done, but a small proportion are successful in their dealings with subordinates. This requires a special tact which is seldom acquired. Men cannot be regarded as so many machines. The human and the humane side of the question must be considered. An interest taken in the general welfare of employees; consideration for their families and an occasional "heart-to-heart" talk with one or more of them will go a long way toward securing their earnest and hearty co-operation.

Nevertheless, a distinguished railroad president of wide and varied practical experience in subordinate service, comments as follows:

> "The arguments for Brown's system are very attractive, but I do not believe the method is adaptable to this wicked world. You may catch flies with molasses, but our lives, our fortunes, our civilization we owe to our jails, penitentiaries and gallows. Next to the influence of the labor unions, I think the greatest element in the general deterioration of discipline, so manifest in late years, is the general use of Brown's method. The records should of course be kept. They were kept by the Pennsylvania lines before Brown's system was heard of. My experience leads me to believe that the bulletins soon fail to be read by the men. If the investigations are properly conducted, with all the men of the crews present when the finding is announced, and pains then taken to draw and enforce the lesson, I believe in the long run much better results are obtained. As to punishment, I do not see how we can safely eliminate it, and in any event the gap is wide between chiding and dismissal."

President Brown, of the New York Central, laid down these carefully thoughtout rules for the consideration and guidance of all his employees:

> "Co-operation between every department of this system is essential to its success. This means not only sincere, heartfelt interest in the welfare of the system as a whole, but personal friendship for the officers and employees of other departments and an eagerness to assist all departments, so far as possible, in order that the best results for the entire system may be accomplished.
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> "It should be remembered at all times that the pay of every man in the employ of the company comes from the same source and that only by serving the best interests of the whole system can any department serve its own best interests.
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> "In other words, in order to secure the most effective results for the company and likewise for every individual in the service, it is of the utmost importance that the entire staff of the New York Central lines should work together as one harmonious family and it is the earnest request of the management that this spirit shall prevail in all departments.
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> "The spirit of co-operation should extend to the relation of the road and its employees to the public. The railroad cannot prosper unless the communities it serves are prosperous.

"The public judges the railroad very largely by the attitude of the representative with whom they come in immediate contact. Kindly courtesy upon the part of subordinate officials and employees costs nothing to the employees, but to the railroad it is an asset of very great value."

Mr. W. J. Harahan, Vice President of the Erie, said:

"Good organization and its resulting element, system, are among the greatest of all requirements, for without them no large business can be properly conducted. When good organization is attained, system naturally follows and system is essential because no one officer, beyond a certain grade, is able to physically keep up with the infinite details occurring in the handling of a large property. The amount of detail is, necessarily, in proportion to the position occupied, the work of the minor officer being practically all detail. Let me remark, however, that there are a great many officers who make the mistake of not knowing enough of detail, although it is true that many attempt too much. It is impossible to lay down any definite rules governing the amount of detail which should be handled, but a man should know enough to be intimately familiar with his work. The necessity for the most perfect system should be uppermost in man's mind as he goes upward. He should surround himself with the most capable men he can find for the respective positions under him. Some men, by their actions, seem to feel that brilliant subordinates may detract from them. There can be no more mistaken idea, nor can there be a more short-sighted policy. A man of moderate capacity can, in a relatively high position, be successful with good and capable subordinates—but a brilliant man cannot be successful with incompetent subordinates, because of the very physical impossibility aforementioned of one individual knowing the details of a large business. The ability to select capable subordinates is a most important art and most necessary to success. To do so properly requires that a man should be somewhat of a student of human nature and an analyst of the human character; it also requires a close and careful supervision of the work of those under him, to know their capability, because there should always be understudies who can be promoted to the various positions, otherwise the organization will become weak. Organization and system, therefore, are most vital elements; in fact they are the very life-blood of a large corporation. Each man should be entrusted with whatever responsibilities the duties of his position and the general organization of the company will allow. To deny officers' authority is to dwarf and stunt them and thus thwart their efforts. My personal opinion is that a great deal should be entrusted to the divisional organization so that the man on the ground could accomplish more, the idea being that the men selected for such positions should be capable of carrying out such an organization rather than to attempt to centralize, because such a localized authority means a more intimate intercourse between the men on the ground and the public; and, I believe, tends to a better understanding between the railroad company and the public because the railroad is more literally and intimately personified in the person of such a representative. . . . . . The treatment of men is a problem usually solved by the individual as his disposition seems to dictate. Its proper solution is a necessary element of success. There is no truer saying than that 'Familiarity breeds contempt.' To become too familiar with men means a loss of their respect, yet to stand aloof and icily distant means also a loss of respect on their part and certainly tends to prevent any enthusiasm for their work. There is a middle course which should be adopted. There should be an easy bearing between the officer and men which will beget confidence on their part and make them feel that the officer is their friend and will always do them full justice whenever anything occurs. If officers coming in contact with the men are on proper terms with them, they will often be advised of things inimical to the company's or their interest, especially if the officers display interest when receiving such advice."

Where two or more roads operate in contiguous territory and pay their employees on different wage scales, the effect on discipline is marked; the roads paying the higher rates being enabled to maintain a correspondingly higher standard of discipline.

The influence on discipline of wages paid was noted in the following incident in the experience of the writer. There were two railroads in the same section of the country, operating under quite similar conditions, except that one road was financially and physically stronger than the other. The stronger line had the better track, equipment, signalling, etc., and in addition to its ability, in consequence, to get its trains over the line with certainty, punctuality, safety and comfort, paid slightly higher wages than its competitor. In its terminals the same relatively superior conditions existed. Better facilities and regular road movements kept its terminals open for free movements and this, in turn, made employment in the yards and in train service more desirable and more sought after. The result in the way of discipline may be readily guessed. The strong road had more applicants for positions than it could accommodate; the other line was, at times, hard pressed for sufficient help. The men who were discharged on the former line because of violations of rules or decreasing traffic were usually employed by the weaker road. On the other hand, when men were needed on the stronger line they were generally recruited from among the most desirable employees of the weaker, the latter being in effect a preparatory training school for the former. This was, in itself a system of discipline which worked to the benefit of the stronger road. On the other line, the effect was, of course, the opposite and constantly tended to harass and embarrass its operating officers.

An instance is recalled where a trainmaster undertook to work a rapid and radical reform on his division by secreting himself at unexpected places about the terminals and along the line to watch the performance of his men. It worked for a few days. The men inaugurated a very complete and successful method of checking the trainmaster. By a system of hand and telegraphic signals they kept themselves thoroughly informed as to his whereabouts. The watcher was watched. The result was the opposite from that desired by the trainmaster and the lack of confidence shown in the men did not increase their respect for their superior officer.

By proper and discreet handling any division or terminal officer should secure the confidence of his men, at least of the better element among them, so as to enable him to keep reasonably well informed of any general violation of rules or serious defects in judgment. This will enable him to keep the whole machine pretty well keyed up. The men will do this, usually, for their own protection and the general good if it is carefully explained to them so that they will see it in the right light and understand the advantage to themselves.

The following is from the "Railway Age Gazette":

> "A high corps spirit is one of the valuable assets of a railroad company. Perhaps in times of close competition it is one of the most valuable. Money cannot make this; general orders cannot make it; it is a plant of slow growth. A year of arrogance, or stupidity, or coarse sense of justice, may destroy the growth of years. We have all seen, time and again, examples of the truth of this statement; and here we suggest a matter for the serious meditation of the gentlemen who have suddenly taken on such importance in the railroad world. The prosperity of a great undertaking depends ultimately on the skill, zeal, and devotion of its servants. That fact we cannot get away from, although we are sometimes tempted to forget it. No ability in combination of ownerships; no lavish expenditure in physical improvement; no headquarters orders for economy all along the line, can command prosperity without the devoted co-operation of the working staff.
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> "The notions which underlie . . . . . the modern theory of railroad organization are careful selection with regard to physical, intellectual and moral qualities; steady promotion by merit, with decent regard to seniority, other things being equal; constant watch of the corps and prompt removal of vitiating elements; fixity of tenure."

Hard and fast rules with reference to discipline cannot be made. The question revolves itself into getting as much for your money as you can. The law of supply and demand largely governs the labor situation and operating officers must adapt themselves to the condition. The labor question is one of the primary factors in building up dicipline. The rate of wages has an important bearing on discipline. A traffic officer has said that freight rates were regulated by "comparison, competition and compromise." This holds true of the adjustment of wages.

With the enormous growth of railroad traffic and the consequent necessity of closer attention to details, with the introduction of intricate machinery, as in automatic and mechanical signaling, the age of the specialist in railroad work has been reached. Special training is necessary to care for special branches of railroad work. The specialist in his legitimate field, with correct methods and under a proper system of organization, is of great value to the railroad as a whole and indispensable to the special work in which he is engaged. By placing these expert observers in position to ignore or harass the local or division officers, however, and having them report direct to general officers, the effect on the organization may in some instances be bad. A feeling may be created among subordinate officers that no matter what they do, whether good railroad practice or not, they are liable to be criticized by one of the specialists. Under certain methods of organization, these men may occupy the position of being able to claim what glory there may be for good results, while not being responsible for any poor showing that is made. As a rule the specialist is a theorist, strong in his convictions. He is invariably closely in touch with the head of the company. It is dangerous to oppose him, except in a diplomatic way, which takes time and taxes the mind and patience of the operating officer. It annoys and worries him and takes his mind from more important work. Nothing is more distasteful to the subordinate officer than the demand for letter-writing. It causes him to neglect his work and consequently lose touch with the actual details. It is distasteful to the subordinate because he sees nothing gained by it, while the time he is frittering away is largely lost for the work he is anxious to accomplish and which he knows is more important. These remarks apply only where the specialist is but partially equipped for his position of authority.

The working officer whose time is largely taken up with office correspondence is in the same difficulty as the engineman who fritters away his air pressure on a long descending grade by making a number of light applications without giving time to recharge his reservoirs. In both cases the operating officer and the engineman are traveling down-hill at an increasing rate of speed and both may hit the bottom very hard.

A so-called expert was recently appointed on a trunk line. His duty, so far as could be determined, consisted in making recommendations to increase the safety of train movements and following them up to see that they were faithfully carried out. On the face of it, this seemed commendable and desirable. The expert was an extremist and was in no way responsible for congestion to traffic or increased cost of handling. A rapid-fire gun was directed against the division officers; impracticable propositions were advanced along with a few good ones to prevent accidents. Some of them would have put the road out of business during the months of heavy traffic; most of them involved increased cost; while many of the recommendations could not be entertained. They kept the division officers on the defensive, glued to their desks explaining why the recommendations should not be acted upon. It did not have the effect of improving the service because the officers could not give the work the close personal attention they did before the advent of the specialist. This is merely one illustrative case where the specialist retarded the work of the machine instead of aiding it.

Men who are trained in special work only, and not on broad lines, can only hope to advance in narrow lines. A road foreman of engines, for example, who only interests himself sufficiently to know that engines are being properly handled and fired, is hardly competent to fill the position he holds. Any engineman could or should know and do as much. The road foreman's position is one above the capabilities of the ordinary engineman. If he does not interest himself in matters outside of the management of an engine he is of little use. It is safe to say he will not be considered good timber for advancement to a higher position. The extent to which he interests himself in all operating problems is the measure of his ability to fit himself to assume increased responsibility. It is not to be expected that any employee will be considered for a position with increased responsibilities and compensation, until he has demonstrated that he not only is capable of, but actually is, earning more than he receives in his present position.

The men employed by a railroad are usually widely scattered and most of them are not under the direct supervision of an officer. Even the conductor of a train cannot always keep the members of his crew in sight. It is essential, therefore, that every man from the lowest to the highest be impressed with the necessity of doing everything that he should do and nothing that he should not do. Every employee should be made to feel that explicit confidence is reposed in him; that the fact of his retention in the service in itself indicates confidence in his loyalty, honesty, ability and application. The writer is convinced after many years of experimenting with different systems of discipline that the so-called "spotting" method does not always produce the best results. Men may be browbeaten into doing their work, possibily, with threats of dismissal or the knowledge that they are being watched and spied upon; but this work will be sluggish. It will lack that snap so noticeable on well-managed roads.

Having and showing confidence does not imply absence of supervision. Of honest, open, intelligent and constant supervision, too much cannot be had; when railroad officers try to carry out false ideas of economy there is usually too little. This supervision carries with it constant and untiring education of employees. The value of this is not generally recognized. It is occasionally underrated because of the incompetency of the officers entrusted with educating the men.

CHAPTER IX

LOADING CARS

The President of a trunk line said: "First load your cars; then load your trains." The car loading is the more important and vastly more difficult to check and control. The train load is apparent, either to the eye of an experienced officer passing over the road, or by casual glance at the train sheets which tell the story of trains run, light engine mileage, engines underloaded, train tonnage, direction of movement and all the other ills of train service. Not so with the car loading. If the doors on empty box cars are closed, the loads and empties look alike, as the seals may not be detected. Only the closest and most constant supervision and checking will determine whether the agent and the house foreman are intelligently doing their full duty. There are the vital questions; (1) whether the cars are utilized to the fullest extent by securing the heaviest practicable load consistent with despatch in movement of freight and avoidance of damage; (2) whether the contents are properly racked and distributed to withstand shocks in transit; (3) whether heavy articles are being placed on top of fragile ones; and (4) whether oil or other freight of that character is loaded alongside of flour. There are also questions of (5) loading l.c.l. freight into the cars that will take it to the proper destination or transfer point; (6) of securing proper weight and kind of cars; and (7) of using foreign cars that would otherwise travel home empty.

Full cars may not always be obtained because,

(a) of insufficient freight for the destination;

(b) commodities fill up in volume but run light in weight;

(c) of difficulty in loading cars fully and consequent tendency to start new cars.

The universal use of automatic couplers, and the remarkable increase in the size and weight of locomotives and cars, increase the liability of damage to freight and make necessary greater care in loading and switching. Freight-house men must be taught to load large cars with package freight so as to prevent shifting. After part of such a car is unloaded, the remainder must be arranged to avoid shifting. When the old link-and-pin couplings were in use, the brakemen had to go between the cars as they were approaching each other to couple and they had to guide the links with their hands. Sticks were used only in the rule books and while within the range of the superintendent's or trainmaster's vision. The brakemen in those days were, in a sense, law-makers. Their rules, had more weight and were more respected by the enginemen than those issued by the company. This was natural. The brakemen knew the safe speed for hand coupling and they did not hesitate, when narrowly missing the loss of fingers or a hand, to bring powerful arguments to bear on the engineman, backed by a coupling pin or link. These weapons have since disappeared. Urging the yardmen to get out trains faster, to do more work in a given length of time, usually results in more damage to contents of cars. Many serious breaks-in-two on the road are caused by damage done to couplers or draw gear while trains are being made up in the yard. Most yardmasters and their assistants dislike to reprimand or discipline employees for doing rough work, so long as there is no visible damage, because they fear a slowing down in the movements of the men. Possibly too, the nightmare of a congested terminal may have something to do with it.

Employees are liable to become careless in the handling of freight unless closely followed up. After unloading a half car, they will often leave the remainder four or five tiers high instead of breaking it down and arranging it so it will not become damaged when the car is moved. Freight conductors have been known to unload freight in the rain at some small station instead of taking it by and returning it the next day. Failure to remove seals, after unloading a car, may cause error or confusion, when the car is again loaded or started empty. Old side cards too should be carefully removed after they have served their purpose.

The day may come when American railroads will overcome that prolific source of trouble, the car arriving at its destination without the waybill, or the waybill reaching its destination without the car. It will be overcome by arranging a receptacle inside each box car, into which the waybills for that car may be placed and the waybill should be a triplicate copy of the shipping receipt. A car reaching the freight-house or team delivery yard will have its freight delivered immediately and if the waybill at originating point is properly made out, it may also be used for freight delivery bill and receipt. The saving in clerical work would be enormous, the loss of time in delivery greatly reduced, and vast economies effected in switching service and freight handling in the freight-houses. Until this millenium is attained, the necessity for having waybills reach destination with the freight is great. Much complaint results because of the failure to get waybills to destination on time. Claims for lost and damaged freight; opportunity for theft and delays, expensive handling and unnecessary clerical work are some of the difficulties resulting.

Increased service from equipment may be brought about largely by a proper loading system which insures the placing of freight in the right cars. Proper points should be designated at which freight from each individual station for all other stations may be transferred. This requires an intimate knowledge of conditions and a carefully worked out schedule subject to occasional revision as conditions change. At each transfer station a loading program must be worked out, dovetailing into the larger general plan for the road as a whole. Another is needed for smaller stations, and finally one for the conductors of local freight-trains. Much loss and damage to freight, loss of use of freight equipment, slow time, and improper deliveries may result from lack of intelligent handling or improper or insufficient instructions to the local freight conductors.

Instructions requiring freight to be loaded direct to certain large stations or to certain sub-stations or piers in controlled territory, with a specified minimum per car, should be issued to all concerned, including agents at stations and transfer points and local freight conductors. When the minimum load is not available, the instructions should specify the transfer point to which the freight should be sent to be consolidated, or state how long such freight may be held at originating point to secure the required minimum for a straight car for any destination. Freight for certain districts, including a number of smaller stations, is usually loaded to the transfer station just in advance of the territory, although in many cases, it may make better time or be more economically handled by loading it beyond its destination and arranging for its return. The general object is, of course, to get the greatest possible service out of cars with the least expense and this involves consideration, primarily, of time and mileage. While maximum load is the goal, it is not always in the interest of economy and good service to seek this blindly to the exclusion of other features. Foreign cars when not in demand, may be started homeward with a light load. In this the judgment of the individual must finally determine how long it will be permissible to hold the car for a certain lading. He must figure on the amount of per diem charges involved, the distance the commodity and the car move, the supply of cars at hand and the demand therefor, the train service, etc. In the handling of system cars the officer in charge of car service may, for the guidance of his subordinates, lay down the general proposition that in the predominating traffic direction cars should be loaded to their full capacity and worked to necessary transfer points to avoid as far as possible any movement without full tonnage. When the predominating traffic direction changes, his instructions necessarily require revision. The traffic in both directions may nearly balance for a while, when heavy loading is desirable. In the direction of light traffic, cars may usually be loaded light and cars forwarded to stations with comparatively light loads, to save time and reduce handling. Time is an important element, as there is naturally keen competition for traffic in the direction in which light cars move, while the condition in the opposite direction may be such that no great effort is made to secure additional tonnage. Power or facilities may be taxed to their utmost and cars in which to move the business offered may be difficult to obtain. The last contingency may again affect the methods of loading in the direction of the empty-car movement.

It is instructive and impressive to know the value of an ordinary box car. Under the instructions of the American Railway Association, a committee of five railway officers analyzed the cost of owning a freight car, to arrive at a figure which would be proper for rental purposes. From the mass of figures gathered, covering six years (1902 to 1907, inclusive) they deduced the following:

Item	Cost in cents per day	Cost per year
Interest, 5 per cent	9.12	$ 33.28
Taxes	.61	2.25
Depreciation	5.71	20.84
Maintenance	14.42	52.61
Incidentals	4.56	16.64
Total	34.42	$125.62

It may seem good practice to load cars light, or to load below the prescribed minimum to certain stations, in order to save time and eliminate additional handling. If this tends to delay the movement of empty cars at a time when such cars are in demand for return loading, it becomes objectionable. To illustrate: A station of some importance on a branch line, perhaps 100 miles away from the main line, necessitates for every car going there, a haul of 200 miles from the time it leaves the main line junction until it returns. If the contents of ten or twelve cars may be transferred into four or five cars at the junction, or the regularly designated transfer in advance, it will be economy to go to the additional expense of transferring and incur the risk due to handling in order to save the mileage and get perhaps two or three days' additional service out of the seven or eight cars. This is an extreme case and the saving of the mileage may justify the transfer at any time, although this is dependent largely on the characteristics of the line, the distance, amount of business, fixed train service, and car supply.

Take the case of a station on the main line, to which a number of cars may be moving in the light-car direction, and which is located midway between division terminals and transfer points. The object is to utilize empty-car movement to the utmost by taking advantage of the light engine mileage made necessary in balancing power. The traffic conditions may be such as to necessitate cutting these cars out at the first division terminal, awaiting the local freight of the following day, and the movement of the empties from the point where released will be by local freight, one, two, and probably three days later. On arrival at the next division terminal they again await their turn on the classification lead and move out on some following train. In such cases the unloading, consolidation and reduction of the number of cars at the first transfer point reached may be justified by the additional number of days' service to be gotten out of some of the cars. The saving in per diem charges is another argument in favor of the additional handling. The whole question is one requiring constant watching and changes in the program without hesitation when conditions require.

The points to be studied in trying to effect economies in loading cars may be summarized as follows:

1. Loading to avoid all transfer if possible.
2. Loading to transfer farthest from originating point.
3. The avoidance of too light loading from transfers to other transfers, as it is many times more economical and time-saving to hold freight over one day and secure consolidated tonnage.
4. Consideration and action on the fact that short distances should not always govern the handling of short-line traffic, as loading to a transfer which receives and distributes from a large number of stations often warrants longer mileage to secure prompt movement of cars and freight.
5. The loading of proper cars, especially with a view to quick handling of foreign equipment.
6. Checking arrival and departure of all cars for transfers and seeing that they are promptly placed at platforms and forwarded.
7. Reporting to the freight accounting department delays to freight by non-arrival of waybills.
8. Careful consideration of freight-train schedules in connection with proposed transfer movements.
9. Consideration, in connection with actual experience, of the best method of forwarding in both directions l.c.l. freight to and from eastern and western divisions, laying particular stress upon improving transfers within home territory.
10. The proper storing of freight to withstand transportation.

The manager of the transfer station and the freight-house has the opportunity to contribute largely to good service and to materially reduce the cost of handling. The one great difficulty at these points is that of inducing those in charge to take a broad view of the general conditions on the line instead of confining their vision entirely to their own transfer or freight-house to the exclusion of the remainder of the line. In their efforts to reduce the cost of handling at the platforms under their immediate charge they may abnormally increase the cost at other points or along the line generally. A car to be handled by a local freight may be badly loaded, and such hurried loading at the transfer may save a few cents at that point. The rehandling or return of freight to the house and the reloading or holding for another car instead of loading beyond the point of delivery and requiring its return, may cost the railroad many dollars in consuming the time of an engine and entire freight crew. The time taken in hunting for the freight wanted, unloading and reloading, damage claims resulting from exposure or additional handling at points where facilities provided are meager, and the occupation of the main track to the exasperation of the train-dispatcher and the crews of other freight trains, are costly. This slovenly work at transfer stations, and at other loading points is one of the difficult things to check. One of the best remedies is a wideawake, intelligent trainmaster who unexpectedly starts out with a local freight, takes possession of all the conductors' waybills, and notes the condition of the interior of each car as the various stations are reached. He will not stop at the question of loading in station order; method of loading; putting flour in proximity to oils or syrup barrels; safes or stoves on top of bric-a-brac; freight for points on other divisions or districts having to be rehandled and returned; but will also note the manner in which freight is being loaded at transfers on divisions over which he has no jurisdiction. Such information and any suggestions occurring to him he should convey to the officers in charge of car service.

It is more expensive to haul an empty car of 80,000 lb. capacity than one of 40,000 lb. Therefore, if a shipment can be handled in a lighter car it should be done, and cars ordered accordingly. At the same time, a heavier car, or a number of heavier cars should be used if thereby the shipment can be forwarded in fewer cars. The heavy load is most desirable for economical operation. Assume an 80,000-lb. capacity car loaded with grain, to 10 per cent. above the marked capacity. At a freight rate of 15 cents per 100 lb. this load would earn $132. A 60,000-lb. car similarly loaded would earn $99 and a 40,000-lb. car, $66. It costs at least 2 cents a mile to haul an empty car.

The rules for handling explosives and inflammables should be carefully studied and followed. These are easily obtainable.

While not strictly a part of a chapter dealing with loading cars, it is believed that the following suggestions (formulated by a committee of the American Railway Association) for handling oil cars involved in wrecks, will prove of interest:

1. Action in any particular case will depend on circumstances, and good judgment will be necessary to avoid disastrous fires on the one hand and the useless sacrifice of valuable property on the other.

Volatile (or combustible) liquids, such as gasoline, naphtha, etc., in large quantity and spread over a large surface, will form vapors that may be ignited at a considerable distance, depending on the kind and quantity of liquid and the direction and force of the wind. Many of the liquids, regarded as safe to carry under ordinary conditions and transported in tank cars without the inflammable placard, should still be treated as dangerous in handling a wreck.

2. When oil cars are leaking all lights or fires near them that can possibly be

dispensed with should be extinguished or removed. Incandescent electric lights, or portable electric flashlights, are safe.

Lanterns necessarily used for signaling should be kept on the windward side and at as high an elevation as can be obtained. The vapors will go with the wind. The ashpan and fire-box of a locomotive or steam derrick, especially on the leeward side of a wrecked or leaking tank car, is a source of danger. Wrecks involving oil cars should in no case be approached with lighted pipes, cigars or cigarettes.

3. To prevent explosion of loaded tank cars that are not supplied with safety valves and are in danger of being subjected to heat from a fire, and that cannot be removed to a place of safety, the manholes should be opened, but only while subject to this danger. When manholes cannot be opened, or, on account of position of the car, valves are inoperative, ventage should be secured by puncturing in the tank four or five small holes near the top, in any convenient way, to secure ventage equal to that of a hole 3 in. in diameter.

4. Effort should be made to prevent the spread of oil over a large surface by collecting it in any available vessels or draining it into a hole or depression at a safe distance from the track. When necessary, trenches should be dug for this purpose.

It is not safe to drain inflammable oil in large quantity into a sewer, since vapors may thus be carried to distant points and there ignited. Care should also be exercised, on account of possible claims for damages, not to permit oil to drain into streams of water used by irrigation plants or for watering stock. Dry earth spread over spilled oil will decrease the rate of evaporation and the danger. A stream of oil on the ground should be dammed, and dry earth thrown on the liquid as it collects.

5. Sudden shocks or jars that might produce sparks or friction should be avoided. When possible, jack the wrecked cars carefully into position, after removing other cars and freight that might be injured by fire. Only as a last resort should the wreck be cleared by dragging, and when this is done all persons should be kept at a safe distance.

6. No unnecessary attempt should be made to transport an injured tank car from which inflammable liquid is leaking. If wrecked, or derailed, and not in a position to obstruct or endanger traffic, it should have its leak stopped as far as possible, and left under guard until another tank car, or sufficient vessels, can be provided for the transfer of the liquid, which should be transferred by pumping when practicable.

7. An empty, or partially empty, oil car, with or without placards, is very liable to contain explosive gases, and lights must not be brought near it.

8. *Water will not quench an oil fire.* If the fire cannot be smothered by use of earth or wet blankets, effort should be concentrated on confining it and saving other property.

9. Should a leak occur by the breaking or displacing of the unloading valve and pipe at the bottom of the car, it can be frequently stopped by removing the dome cap on top of the tank and dropping the plunger into the plunger seat, as a shock sufficient to injure the outlet valve and pipes may have also unseated the plunger.

The Chicago & North-Western found the cost per 1000 ton-miles[1] during different years, for settling loss and damage claims, to be:

1898	2.307 cts.	1905	7.210 cts.
1902	4.149 cts.	1906	6.261 "
1903	6.226 cts.	1907	8.805 "
1904	8.058 cts.	1908	13.320 "

If the claims of 1908 could have been settled on the same basis as in the year 1905 (7.210), the amount would have been $348,750.65, instead of $644,407.64, a saving of $295,656.99; or approximately, 46 per cent. less.

To reduce these amounts it was determined to increase supervision and see that employees were familiar with and observed the rules. It was decided also to pay more attention to supervision of the receiving, waybilling, transporting and delivering of freight; to employ on heavy way freight trains two men whose duties it should be to load and unload and properly stow freight on such trains, the conductor to be held responsible. The superintendent, as far as possible, was to select the entire train and engine crew on way freight trains and avoid changes in personnel of these crews. It was also recommended that inspectors be appointed at the larger stations to supervise loading and unloading of freight.

The movement developed that the following were the principal causes of the increase in loss and damage claims:

(1) Lack of interest by employees. (2) Lack of knowledge of the rules. (3) Failure to comply with the rules when known. (4) Failure to check property before receipting for it. (5) Receipting for more than is actually delivered. (6) Receipting for property as in good order when it is in bad condition. (7) Giving clean receipts for property loaded by shipper and not checked. (8) Failure to check freight properly when delivered to consignee. (9) Failure to report shortages, damages and overs promptly and properly. (10) Failure to notify consignees promptly and properly of the arrival of freight and to keep a record of such notice. (11) Making greater advances on property than its value warrants. (12) Delivering property to persons other than the consignee without the proper order. (13) Mistakes in billing caused by failure to compare waybills with shipping instructions. (14) Forwarding freight not marked with name of consignee and destination. (15) Improper loading, stowing and bracing freight. (16) Loading freight in dirty or leaky or otherwise unfit cars. (17) Carelessness in taking and transmitting verbal shipping instructions (especially on the telephone). (18) Improper use of airbrakes. (19) Failure to give prompt notice of refused and unclaimed freight. (20) Failure to ice cars properly in warm and heat them in cold weather.

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[1] The average for the United States in 1908 was 1.25 cents; in 1909, 1.13 cents.

When the general pooling of cars regardless of ownership is arranged, loading methods will be simplified, the cost of switching reduced and many other economies introduced. The Committee of the American Railway Association on Car Efficiency is endeavoring to bring about this result and it will doubtless succeed. During car shortage periods cars are pooled—not theoretically but actually. Cars are pooled in Germany, where the agreement for the co-operation of the state railways of the different states went into effect April 1, 1909—and each state contributed a certain agreed-upon proportion of cars for joint use.

The spectacle of American railroads, rushing a class of freight cars off their lines and loading other similar cars in the same direction, thereby hauling many more cars than are necessary to move the freight and "cross-hauling" empty cars—that is, empties in both directions at the same time—merely to avoid a book-keeping balance against a road, is in striking contrast to the logical, business-like methods of our German friends in this respect. Undoubtedly the pooling of freight cars will eventually be brought about and stop the enormous leak, and when it does come, it will be surprising to all except those who have given the subject much study, to observe the greatly improved efficiency in the handling of the car supply as well as the extensive economies resulting from the heavy reduction in car-mileage.

CHAPTER X

MAKING UP TRAINS

General principles.—The first destination of a car is governed by its contents and the loading program. The general practice of getting trains out of terminals as a matter of convenience to that particular terminal alone and without regard to the safe movement over the line to the next terminal, cannot be condemned too severely, unless extreme conditions compel it. It means duplication of work at the following terminals and the loss of time along the line. Lack of system is pernicious and unbusiness like. There are cases, however, where the facilities at one terminal are so inadequate that a part of its work must be shifted to another.

Make-up policy.—Trains should be made up to go to single destinations as far as practicable; but this frequently entails too much delay in waiting for the necessary number of cars at the starting terminal to get a solid train. Where it is impracticable to make up a train with all its cars for one destination, the cars should be assembled with a view to running the train without further switching, to the most distant breaking-up point possible. The only limitations to carrying out this method are the time cars may be held to get enough together for one destination or breaking-up point (for reclassifying) and the ability with the facilities provided, at the starting point, to hold cars for that purpose without causing congestion or interference to an extent that will increase the cost of switching. The subsequent saving in time and work will justify a considerable detention at the originating terminal. The limitation is apt to be the needs of the consignees.

Following out this general plan, it is to be expected that a few of the cars in such through-trains will "fall by the way-side" because of hot journals, broken trucks and other car disabilities. Where these cars cannot be made ready to go forward in the same train without undue detention, arrangements should be made to forward other cars for the same destination in their places. In the absence of such cars, those for a divisional terminal may be added, to enable the full tonnage rating to be maintained, unless the direction is that of light traffic, but they should be placed so as to permit of their removal without delay or unnecessary switching. The distributing trains for the division and the local freights are supposed to be made up in station order, with first cars to be set off next to engine, and so on.

Position of platform cars.—The cars containing the "break-bulk" or platform (l.c.l.) freight are usually placed next to the caboose, although practice varies considerably in this respect. On a heavy local run, in districts where the track occupation is dense, this plan possesses considerable merit. The front part of the train may be engaged in doing the switching for the station and industries, while the platform cars are placed alongside the freight-house and being worked at the same time. Where the conditions alluded to warrant it, many trainmen may, in this manner, be worked to advantage.

Livestock.—It is considered good practice to handle livestock at or near the front end of the train, to reduce the shock, and to facilitate the quick delivery on arrival at destination.

Explosives.—Cars containing explosives must not be hauled in a passenger train; nor in a mixed train when it can be avoided, and at least 15 cars from the engine and 10 cars from the caboose in through road freight trains when length of train will permit; in local freight and shifting trains, these cars must be coupled in the air service and placed as near the center of the train as possible. They must be placed between box cars not loaded with inflammable articles, charcoal, cotton, acid, lumber, iron, pipe, or other articles liable to break through end of car from rough handling. When explosives are loaded in steel underframe cars, such cars may be placed in train between steel hopper cars. All cars containing explosives must have air- and handbrakes in service.

When handled in yards or on sidings, cars containing explosives must be coupled to an engine with a car between unless it is practically impossible to do this, and they must not be cut off while in motion. Couplings must be made carefully and unnecessary shocks avoided; nor must other cars be permitted to strike such cars. They must be so placed in yards or on sidings that they will be subject to as little handling as possible, removed from all danger of fire, and, when avoidable, engines on parallel tracks must not be allowed to stand opposite or near them.

Explosives include black or brown powder, dynamite and other high explosives, smokeless powder for small arms, fulminates, blasting caps, electric blasting caps, ammunition for cannons, explosive projectiles and detonating fuses. A square placard on each side with the name explosive designates a car containing explosives.

Inflammables.—Tank cars containing inflammables must be placed at least five cars from engine and five cars from caboose, if possible; if length of train does not permit this they must be placed as near the middle of the train as practicable. In switching, a car containing inflammables must not be started down a ladder track, incline or hump, until the preceding car has cleared the ladder. It must also clear the ladder before another car is allowed to follow. A car containing inflammables is designated by a diagonal placard placed thereon.

Empty or loaded flat cars, empty oil tanks, and, at times, empty or loaded gondolas, with low sides are required to be kept at the rear end to minimize the liability of such cars having their bodies broken in two; especially when handled in long trains partially airbraked. This precaution is hardly necessary with the modern heavy capacity steel flat and gondola cars as they will withstand a more severe shock than wooden box cars. Passenger cars on freight trains should be kept at the rear end to avoid damaging platforms and straining their longitudinal framing.

Loads and empties.—A general rule to keep the loads ahead and empties in the rear, is an old and good one. There is some difference of opinion as to the merits of the claim that trains so made up pull easier. In some dynamometer tests no difference was observed. Trains made up with loads ahead are less likely to part on hilly or "choppy" roads, and there is reduced liability of damage to equipment and contents where the slack runs in and out in making stops. This shock is more severe on partially airbraked trains than on fully equipped trains. The enactment of the safety appliance law, requiring among other things that at least 85 per cent. of the cars in a freight train shall be equipped with working airbrakes, makes more difficult what was already a difficult and complicated question in train make-up, but the problem is now becoming easier on account of the almost universal use of airbrakes on freight equipment. In 1907 the Master Car Builders' Association amended their rules governing the joint use of freight cars by specifying that cars not equipped with airbrakes would not be accepted in interchange. This action has relegated the non-air car to local service on its owner's lines and it is rapidly disappearing. On July 1, 1911, 99.3 per cent. of freight cars belonging to roads reporting to the American Railway Association, were equipped with airbrake.

Doors to be kept closed.—It is difficult to keep car doors closed on empty cars. Aside from the physical effort required to close many doors, the conductor generally thinks that the open door is the natural symbol for an empty car. When men are disciplined for moving empties as loads and *vice versa,* it is perhaps not surprising that this view is taken. This appeals more forcibly when a conductor and one brakeman are handed cards for 90 or 100 cars and told to clear the yard in 10 minutes. Tramps will more readily board trains containing cars with open doors and there is greater liability of losing doors along the road when open than when closed and latched or hasped. A door partly open, in falling off may cause considerable damage to property and serious personal injuries have been inflicted on double-track roads and along passing tracks where freight-car doors scraped the sides of passenger trains. There is more resistance in a train of empty box cars with open doors, due to the wind or air resistance, and sparks from the engine may lodge inside the car and set it on fire. Perhaps 90 per cent. of freight cars have doors which open by moving to the left, in the car door run-way, as the car is faced from the outside. In a moving train, therefore, the doors on the left side are more liable to open because the stops tend to move the doors forward. The doors on the left side are consequently more likely to spread out or fall off than those on the right side.

Rating locomotives by cars.—Some roads, as a matter of convenience, or because of peculiar local conditions, continue to load their road engines according to the number of loaded cars for which the rating is made. Two empties are then rated as one load. The best results are obtained where the tonnage rating is used and with this a uniformity of loading is secured that at once increases the average train load and improves the general train movement. A record kept by one trunk line of a large number of freight trains showed that 2000-ton trains ran all the way from 27 to 65 loads; the lesser number being a train consisting entirely of steel coal cars of 100,000 lbs. capacity, loaded to 10 per cent. in excess of marked capacity. This, in itself, will indicate the unfairness of the method of rating engines on a car-load basis, and the unsatisfactory results to be obtained therefrom.

Rating by tonnage.—A satisfactory tonnage rating system must make allowance for lightly loaded cars, for empty cars, and weather conditions. The rating should, in the first instance, be made to fit average conditions. Actual service tests form the best basis, but the mistake is frequently made of selecting an engine in the best order, a picked crew, good weather and daylight runs, and giving special attention to dispatching. When it is attempted to haul this maximum tonnage under adverse conditions, such as bad track, heavy head or side winds, low steam pressure due to poorer coal than usual, the train is stalled. The yardmaster is the controlling factor and he must combat the temptation to overload engines merely to open or clear his yard for the time being. The inability of the engines to move and promptly return for another load is too far in the distance for him to figure on, and he therefore loses sight of the fact that, in the end, he has only added to his troubles. Trains move with more difficulty during the night. Hand signals cannot be interpreted as easily as in the daytime, telegraph offices are more infrequent and men are not as active, mentally or physically.

Train resistance and tractive power.—Those having the supervision of making up trains should know how to determine what an engine is capable of drawing over a road of known grade and curvature under certain weather and atmospheric conditions. The tractive power of the engine; that is, the pull in pounds exerted on the drawbar in the rear of the tender, must be known, and then the resistance of the train to be moved.

The theoretical drawbar pull in pounds may be found by the formulas arranged in the following table:

	Tractive power	
Type	Operated simple	Operated compound
Single expansion	$\frac{.8\,Pd^2s}{D}$	
Two-cylinder compound	$\frac{.8\,Pd_h^2s}{D}$	$\frac{.8\,Pd_l^2s}{(R+1)\,D}$
Tandem compound	$\frac{1.15\,Ps}{D}(.66d_h^2+.25d_l^2)$	$\frac{Ps}{D}(.66d_h^2+.25d_l^2)$
Baldwin compound	$\frac{1.8\,Pd_l^2s}{(R+1)D}$	$\frac{1.7\,Pd_l^2s}{(R+1)D}$
Four-cylinder compound	$\frac{1.6\,Pd_h^2s}{D}$	$\frac{1.6\,Pd_l^2s}{(R+1)D}$

P = boiler pressure in lb. per square inch.
d = diameter of cylinder in inches.
s = stroke of piston in inches.
D = diameter of driving wheels in inches.
d_l = diameter of low-pressure cylinder in inches.
d_h = diameter of high pressure cylinder in inches.
R = ratio of cylinder volumes.

An engine with 20-in. × 26-in. cylinders, 60-in drivers and 200 lb. steam pressure on pistons would, according to the formula for simple engines $\left(\frac{.8\times200\times20^2\times26}{60}=27,733\right)$ have 27,733 lb. tractive power at the rim of the drivers. All of this is not available at the rear draw bar of the tender because part of it is used in overcoming the friction of engine machinery and the rolling resistance of the engine and tender. The American Locomotive Company estimates the machinery resistance as 22.2 lb. per ton of engine on drivers, and considers the rolling resistance of engine and tender to equal the rolling resistance of a heavy car—say 4 lb. per ton. If this engine has a weight of 115,000 lb. on drivers, 43,000 lb. on forward truck (total 158,000 lb.) and the tender when loaded weighs 97,000 lb. the resistance of the machinery would be $57.5\times22.2=1276$ lb. The rolling resistance of engine and tender would be $(79+48.5)\times4=510$ lb. or a total resistance of $1276+510=1786$ lb. to be deducted from the tractive force available at the rim of drivers. The net draw bar pull, therefore, would be $27,773-1786=25,947$. Taking again the American Locomotive Co.'s figures for resistance of 40-ton cars at 10 m. p. h. (4.65 lb. per ton), it will be found that this engine should haul $\frac{25,947}{4.65}=5500$ tons on a straight and level track. Such an ideal condition, however, rarely exists. If the road is fortunate enough to have a limiting grade as low as 0.4 per cent. the resistance of the grade would be (at 20 lb. per 1 per cent. grade) 8 lb. per ton, or, plus rolling resistance, (4.65 lb.), 12.65 lb. per ton. The rating for the engine, then, would be $\frac{25.947}{12.65}$ or 2051 tons, which is equivalent to 51 cars averaging 40 tons each.

For four-cylindered compound engines, the Baldwin formula is often used:

$$TF = \frac{Ps}{D}(.66d_h^2 + .25d_l^2)$$

in which, h = high-pressure cylinder, and l = low-pressure cylinder.

All computations as to the hauling capacity of locomotives are based on the assumptions that engines have ample grate area and boiler capacity to supply cylinders with steam at maximum pressure and that there is sufficient weight on the drivers to prevent slipping before the maximum tractive power has been exerted. A committee of the Master Mechanics Association in 1887 recommended these ratios of tractive power to weight on drivers:

Passenger engines,	25. per cent.
Freight engines,	23.5 per cent.
Yard engines,	22. per cent.

on tires half worn.

The train resistance may be made up of the following three parts:

(1) Resistance on a level straight track.
(2) Resistance due to grade.
(3) Resistance due to curves.

The resistance on a level straight track has been the subject of a great many experiments, which, however, have failed to determine satisfactorily a formula for train resistance which is applicable to trains of different character. It ranges from 3 to 8 lb. per ton.

The resistance due to grade is capable of an exact mathematical determination.

The resistance due to curves has been determined by practice sufficiently well to meet the ordinary requirements.

Resistance on Level Straight Track.—This resistance is composed of,

(1) Rolling resistance due to deflection of rail and roadbed under the loaded train.
(2) Journal friction between the journals and bearings of axles.
(3) Atmospheric resistance on the front of the train, the sides and tail.
(4) Oscillation and concussion.

We know very little about the amount of resistance due to rolling friction, and practically nothing about that due to oscillation and concussion, but more or less information has been determined by experiments with reference to journal friction and atmospheric resistances.

These four resistances are usually classed as one and termed Level Straight Track Resistances, and are as a rule given in the form of pounds of resistance per ton of weight of train. This quantity is determined experimentally by various methods, and from these experiments a great many formulas have been derived applicable to the special cases. All of these fail when applied to practical tests and we must necessarily fall back on the results of dynamometer car tests.

Resistance due to grade.—It is customary in America to express grades as a certain per cent.; that is, a certain number of feet vertical rise in 100 ft. horizontal. This on a 1 per cent. grade means 1 ft. rise in 100 ft. horizontal.

By mechanics, with a very slight approximation, it can readily be shown that a grade of 1 per cent. is equivalent to a resistance of 20 lb. per ton of weight of train.

By examining the formula and experiments for level straight track resistances, it will be seen that in case of freight-trains running at ordinary freight-train speed the resistance in pounds per ton is somewhere in the vicinity of from 4 to 8 lb., which when compared with 20 lb. per ton resistance due to a 1 per cent. grade gives a very practical appreciation of the relative importance of lower grades on freight-train lines.

Resistance due to curves.—It is usual to express the resistance due to curves in the form of a grade, and the best practice appears to be to consider that the resistance due to a 1 degree curve is practically the same as a 0.04 per cent. grade, and for a 2 degree curve it is twice as much; and so on.

Since the resistance due to grade is 20 lb. per ton for a 1 per cent. grade, for a 0.04 per cent. grade it will amount to 0.8 lb. per ton. So that the resistance due to a 1 degree curve could just as readily be represented as 0.8 lb. per ton of train.

For example: If a 6 degree curve occurs on a 0.4 per cent. grade, the resistance due to the curvature would be $6 \times 0.8 = 4.8$ lb., and the resistance due to the grade would be $0.4 \times 20 = 8$; or the total resistance due to grade and curve would be 12.8 lb. per ton.

If to this is added the level straight-track resistance obtained from one of the above formulas (depending upon whether the train is a passenger or a freight train), the total resistance in pounds per ton for any given train at any given place on the road such, as on the ruling grade, can be computed.

Limitations in practice.—Having given the actual tractive power of a locomotive, its working limit, due to the track and other conditions, can be determined. An engine will draw a heavier train over heavy, well-supported rail than on a light rail section, with ties spaced at considerable length, and no ballast, or ballast of such a nature as to permit the ties to move or sink. On such inferior or light track there would be a succession of depressions as the engine passes over it, although to the eye it may appear to be fairly well surfaced track. The difference in movement might be compared to a ball running down a well-constructed bowling alley and the same ball rolled over a piece of lawn, both being perfectly level. On the smaller rail section the point of contact between the rail and driving wheel tread is less, reducing the adhesion. When the rail or tie, or both, are worn, the results are less satisfactory. The design of the rail head also affects the adhesion somewhat. Engines regularly running over a light rail section were found to have greatly reduced adhesion on heavier rail sections afterward, because of the grooves worn in tires.

Locomotive capacity.—After the working tractive power has been determined, the number of tons the locomotive can haul at a given speed over the maximum grade can be readily determined by dividing the working tractive power of the locomotive by the total pounds per ton resistance as determined by the method given above.

Use of sand.—Sand for increasing the adhesion between the locomotive drivers and the rail is, at best, a necessary evil. On a good clean rail the train will roll easier, but if slightly wet or greasy, the engine drivers will slip for want of adhesion. Sand, judiciously used, will tend to prevent the slipping by increasing the adhesion, but it will also cause the train to draw harder. It may be used too freely, thereby increasing the troubles instead of diminishing them. The ideal condition would be a sandy rail for the locomotive drivers to pass over and a wet clean rail for all the following wheels of the train. This condition would be approximated by a pneumatic blast or a sweeper behind the last driver to blow the sand off the rail. Inexperienced enginemen stall their trains on sand about as often as they prevent stalling through slipping. Over interlocking plants sand must not be used on account of movable point frogs, slips and switch rails, although often needed badly at those particular points because of the lack of surface of a full rail. The size and contour of the rail section greatly affects adhesion; as does the condition of the driving wheel tires.

Engines are loaded at terminals from three entirely distinct viewpoints, viz.:

1. To move the maximum tonnage consistent with speed requirements on the line.
2. To move the maximum tonnage per day, for a long period of time, including all engines both in or out of service, and
3. To move the tonnage at a minimum cost per ton-mile.

These methods are affected by such helping or assisting engine service, doubling of hills, setting off or picking up of cars between terminals where grades change, and double-heading, as may be required. The tonnage per engine depends on—

1. Rate and length of maximum or "ruling" grade.
2. Average grade.
3. Amount and degree of curvature.

4. Density and character of traffic.
5. Running time allowed.
6. Average gross weight per car.
7. Location and extent of passing track facilities.
8. Weather conditions and temperature.
9. Wind velocity and direction.
10. Condition of rails.
11. Car journal lubrication and condition of journals.

An economical tonnage rating is estimated by one authority to be 80 per cent. of the maximum available drawbar pull, under favorable circumstances. This may be determined by the use of a dynamometer car and should be confirmed by service tests. On one division of a large road it was claimed that by dropping from the full maximum rating of 100 per cent. to an 80 per cent. rating for comparative months in two consecutive years, the tonnage per engine mile was increased 13 per cent., and per train-mile 16 per cent., with a decrease of 9.3 per cent. in coal consumed per ton-mile. If these figures are correct they can only be explained by the large number of cars set off with the higher rating by stalled trains.

An exhaustive series of experiments conducted by Prof. Edward C. Schmidt, in charge of railway engineering at the Experimental Station of the University of Illinois, resulted in the preparation of the following table of the "values of resistance at various speeds and for trains of different average weights per car" applying to trains running at uniform speed on tangent and level track of good construction during weather when the temperature is not lower than 30° F. and when the wind velocity does not exceed about 20 miles per hour.

TRAIN RESISTANCE—POUNDS PER TON

Speed m. p. hr.	Average weights per car, in tons													Speed m. p. hr.
	15	20	25	30	35	40	45	50	55	60	65	70	75	
5	7.6	6.8	6.0	5.4	4.8	4.4	4.0	3.7	3.5	3.3	3.2	3.1	3.0	5
6	7.7	6.9	6.1	5.5	4.9	4.4	4.1	3.8	3.5	3.3	3.2	3.1	3.0	6
7	7.8	7.0	6.2	5.5	5.0	4.5	4.1	3.8	3.6	3.4	3.2	3.1	3.1	7
8	8.0	7.1	6.3	5.6	5.0	4.6	4.2	3.9	3.6	3.4	3.3	3.2	3.1	8
9	8.1	7.2	6.4	5.7	5.1	4.6	4.2	3.9	3.6	3.4	3.3	3.2	3.1	9
10	8.2	7.3	6.5	5.8	5.2	4.7	4.3	4.0	3.7	3.5	3.3	3.2	3.2	10

From the foregoing it will be seen that the resistance on straight level track ranges from 3 to 8.2 lb. per ton, under varying conditions of car weights and speeds.

The arrangement of loaded and empty cars in the front or rear of the train also affects train resistance. Mr. J. M. Daly in a paper read before the New York Railroad Club, October 20, 1905, estimated the resistance when heavily loaded cars are placed in the rear of the train and empty cars in front at 10 per cent. greater than when the loaded cars are placed in the front end of the train. Assuming the resistance of a loaded car in the head of the train as a basis it is undoubtedly true that as the car is placed in consecutive positions farther back in the train the resistance increases in small proportional amounts, due to a correspondingly increased distance the train weight extends from the locomotive. The flange friction in curves is increased as the major portion of the train weight is placed farther from the locomotive.

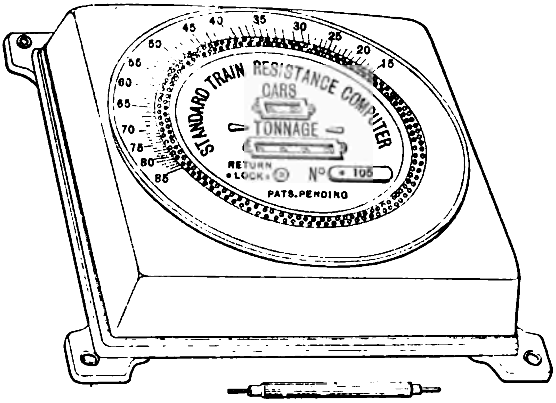

FIG. 47.—Tonnage computing machine.

Tonnage computers.—A simple equated tonnage computer is shown in Fig. 47, devised by Mr. J. M. Daly, General Superintendent of Transportation of the Illinois Central. The object of tonnage computer is to make it possible to load locomotives uniformly, regardless of the number and varying weights of the cars in the trains. The method of adjusting the tonnage and getting the locomotive ratings under this plan is as follows:

The reduction, if any, to be made from the maximum tractive power of the locomotive to allow for the resistance of the engine itself and the tender, also for weather and rail conditions, defects in power, necessity for speed, etc. must be decided upon. If an engine has a maximum tractive power of 40,000 lb. and the desired reduction is 10 per cent., the rating of the engine will be 36,000 lb. draw-bar pull. Next, there must be a unit rating on which to base the resistance of the cars. As the average gross weight of cars is about 40 tons, this weight has been taken by Mr. Daly as his basing unit.

In determining the tonnage rating of a locomotive, it is given a train of as many cars weighing 40 tons, as will cause it to exert 36,000 lb. draw-bar pull on the ruling grade in moving the train at the required speed. If, for example, it can haul 50 of these cars, its rating will be 2000 tons of such unit; but because of the less resistance per ton of heavy cars, it can haul *more* than 2000 tons of cars weighing 50, 60 or 70 tons. Conversely, because of the higher resistance per ton of light cars, it cannot haul 2000 tons made up of cars weighing 30, 20 or 15 tons.

If the locomotive is given a train of cars all weighing 50 tons gross, it will be found that it can haul, say 42 cars, totaling 2100 tons. Therefore, to find what the equivalent engine loading of the heavier car would be on the 40-ton basis, divide 2000 tons by 42, which gives, approximately, 48 tons. Carrying out this same determination for other weights, Mr. Daly has found by experiment that expressed in terms of equivalent resistance of the average car weighing 40 tons:

A 70-ton gross weight car has a loading equivalent of 62 tons.
A 60-ton gross weight car has a loading equivalent of 55 tons.
A 50-ton gross weight car has a loading equivalent of 48 tons.
A 40-ton gross weight car has a loading equivalent of 40 tons.
A 30-ton gross weight car has a loading equivalent of 32 tons.
A 20-ton gross weight car has a loading equivalent of 25 tons.
A 15-ton gross weight car has a loading equivalent of 22 tons.

The computing device is designed to add together the *equivalent* instead of the actual gross tonnage of the cars by automatically recording less than the actual weight of heavy cars and more than the actual weight of light cars.

Description of computer.—The machine is 14 in. × 14 in. and weighs 28 lbs. It has a circular face plate marked with tons and fractions of tons. Within, and concentric with this plate, is a narrow, perforated ring, the perforations coming opposite the divisions on the plate. At the center are two registers, one showing the number of cars and the other the adjusted tonnage. To work the machine, the point of the stylus seen lying below the machine, is inserted in a hole in the movable ring opposite a figure and the ring rotated to the right until the stylus strikes a stop under the plate. The stylus is withdrawn and the operation repeated as many times as there are cars to add, the machine adding the equivalent tonnage each time and showing, on the registers in the center, the total equivalent tonnage and also the actual number of cars that have been added. For example, if the waybill calls for a 60-ton gross weight car, the stylus is put in the hole opposite this number and the ring rotated to the stop.

The register adds only 55 tons, instead of 60 tons; for a car weighing 30 tons it adds 32 tons. When the register shows 2000 tons—if that be the locomotive rating—the train is complete, whether its actual tonnage be 2300 or 1900 tons. The drawbar pull in either case will be the same under like conditions of good track, etc. The advantages and savings claimed for the device are as follows:

Equalized resistance to all freight trains.

Accurate computation of train tonnage.[1]

More accurate handling of waybills.

Saving of one hour per train in departure from terminals because of quicker computation of tonnage.

More room for incoming trains at terminals because of quicker dispatch of outward trains.

Saving of fuel on engines held waiting for conductors to get the waybills and foot up the tonnage; and then to either set out or pick up cars to balance the rating.

Saving of overtime and fuel on trains held out of yard waiting to get in on tracks occupied by trains ready to leave.

Carbon copies of the daily reports of individual train tonnage are sent to the superintendent, the master mechanic, and the superintendent of transportation, and reach their respective desks the next morning. The officers are thereby kept in close touch with the business, and can take immediate steps to fill out trains better. They are also kept better informed as to the condition of the motive power as measured by its performance. Weekly and monthly reports are compiled from the totals of the daily reports with very little expense; three hours' work each month will suffice. The device does away with the mental calculation, thus eliminating many chances for error; it relieves the conductor of annoying work, giving him more time to look after the physical handling of his train. It will increase the average miles per day of both engines and cars.

By checking waybills and computing the tonnage in advance of train movement, missing waybills can be located and "hold cars" can be located and switched out of the train make-up, thereby avoiding delay to road crews after reporting.

The basic principles of correct train loading were stated by the committee on "ton-mile statistics" in its report to the American Railway Master Mechanics' Association, Saratoga, June, 1902, as follows:

"The ton as a unit for making up trains, using the actual weight of cars, has proven more efficient than the car, because it is a more accurate measure of weight and hence the work done by the locomotive.

"The fact has been established beyond successful contradiction that there is no constant relation between the weight of a car and the power required to haul it, but that a ton of empty car requires more power to haul it than a ton of partly loaded car; and this requires more power than a ton of fully loaded car; also, that the greater the capacity of a car the less the power per ton required to handle it when fully loaded.

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[1] As compared with computation without the aid of any mechanical device. The results, of course, are shown in equivalent, not actual, tons.

"The ideal system of tonnage ratings would be one which takes these facts into consideration and would measure accurately the resistance a train will develop, regardless of the number of cars—loads, empties or partly loaded cars—it contains, or their weight or capacity, as it is the resistance a locomotive is capable of overcoming which a tonnage rating should measure, rather than the number of cars or tons it is capable of hauling."

Application of rating formulas.—Whatever formula for tonnage rating may be in use, it should be intelligently applied. Necessary reductions in tonnage rating must be made when conditions on the road are abnormal. An overloaded engine may be a source of greater loss in operating than an underloaded engine. Yardmasters should anticipate as far as possible a sudden fall in temperature, high head winds or side winds, snow, sleet, rain and fog and load engines starting out from the terminal accordingly. A rail is in worse condition after a slight rainfall than after a heavy rain which clears it of all grease and oil.

The extremes of heat and cold occasionally render it necessary to suspend the operation of all formulas. During the excessively hot spell of some two weeks during July, 1911, many men were overcome and had to be taken off their trains to the hospital or their homes. Accidents were numerous. It would have been unwise during such a period not to lighten up engine loading enough to enable trains to keep under way, rather than remain on siding, or dragging up hill at low speed, thereby reducing the number of men available for service, and possibly inviting accident. Extreme cold is similar in its final effects, but works through different channels. When a combination of cold and dampness stiffens up journal bearings to an extent that a train cannot be started out of a siding after a 30-minutes stop, although with greatly reduced tonnage, prompt and unusual steps should be taken by the train dispatcher, and he should conveniently forget the ordinary rules for tonnage rating when from excessively low temperature the water freezes in the injector feed pipes, as has been known.

On many roads a reduction of from 5 to 10 per cent. in the tonnage rating is made for wet rails and 10 to 15 per cent. during the winter season. On one road train-dispatchers are instructed to reduce the normal tonnage rating 5 per cent. when the thermometer falls to freezing, 32° Fahr., 10 per cent. when below 20°, 15 per cent. when between 15° and 10°, 20 per cent. between 10° and 0°, 30 per cent. between 0° and $-10°$ and 40 per cent. when below $-10°$. Reductions are also made by request of the division master mechanic for engines in bad condition and for engines just out of the shop being broken in.

A very valuable contribution to the limited store of exact knowledge on the effect of extremes of temperature on the resistance of trains is contained in a paper read by Professor Edwin C. Schmidt before the Central Railway Club, January, 1912. He gives in detail the result of several tests made to determine the relative resistance under normal and low conditions of temperature. It is shown that the difference is greatest at the beginning of the run because in winter it takes longer to warm up the journals to the point where lubrication is most effective. The tests indicate that the rolling resistance, which averaged 4.5 lb. per ton on one division in summer, increased to 6 lb. per ton with low temperature, or an increased demand of 33.3 per cent. on the hauling power of the engine. These figures take into account only the rolling resistance on a level tangent; grade resistance is not affected by changes in temperature. It follows, therefore, that low temperature calls for a greater reduction in the tonnage ratings of low-grade lines than on roads with heavy grades. Professor Schmidt compares two divisions, the first with a ruling grade of 0.5 per cent; the second with a ruling grade of 1 per cent.; and shows by the following table that the necessary tonnage rating reduction in winter on the first is 14 per cent. and on the second but 10 per cent. The tabulation follows:

	Division A	Division B
Ruling grade, per cent.,	0.5	1
Tractive effort in summer, lbs.	32,000	30,500
Tractive effort in winter, lbs.,	30,400	28,970
Grade resistance, lbs. per ton,	10	20
Net resistance in summer, lbs. per ton,	4.5	4.5
Net resistance in winter, lbs. per ton,	6.0	6.0
Gross resistance in summer, lbs. per ton,	14.5	24.5
Gross resistance in winter, lbs. per ton,	16.0	26.0
Tonnage in summer, tons,	2,207	1,245
Tonnage in winter, tons,	1,900	1,115
Tonnage reduction, per cent.,	14	10

Professor Schmidt compiled an interesting table summarizing current practice on 41 roads in modifying tonnage ratings in winter. The summary is reproduced on page 162.

Figure 48 on page 163, containing curves of frictional resistance, was prepared by the Burlington and shows the relation between resistance per ton and weight of cars under different weather conditions. It is instructive and is one more authority on this important subject.

The effect of journal lubrication on train resistance is important and deserves more attention than is ordinarily given it. One or more heated journals will have an appreciable effect on resistance. Inefficient or insufficient inspection; insufficient lubricating oils or waste, and improperly designed and maintained journal boxes, causing bearings to assume

TONNAGE RATING—SUMMARY OF CURRENT PRACTICE

TONNAGE REDUCTIONS FOR VARIOUS TEMPERATURE CONDITIONS

Road	Minimum temperature for normal rating. Degs. F.	Temperature range	Reductions per cent.	Temperature range	Reductions per cent.	Temperature range	Reductions per cent.	Temperature range	Reductions per cent.	Additional reductions for unusual conditions
Chicago Great Western	*45	45–25	8	25–0	16	0 & below	25			†8 per cent.
Chicago & Eastern Illinois	45	45–32	10	32–15	20	15–0	30	0–10	35	
Chesapeake & Ohio	45	For each 10 deg. change in temperature make 5 per cent. reduction.								Special orders.
Boston & Albany	40	A reduction of from 50 to 150 tons is made from summer rating for winter rating.								Special orders.
New York Cent. & H. R.	50	More or less discretionary. For a drop of 20 deg. reduce about 10 per cent.								Special orders.
Central R. R. of New Jersey	40	40–20	10	20–0	20					Special orders.
Pittsburg & Lake Erie	40	40–20	210 ts	20–10	420 ts	Zero	640–860 ts			Special orders.
Baltimore & Ohio	35	From 35 degs. to zero and below make reductions of from zero to 30 per cent.								Special orders.
Erie	33	33–23	5	23–13	10	13–3	15	Below 3	20	Special orders.
Del., Lack. & Western	32	10 per cent. reduction for below 32 deg. and 15 per cent. reduction for extreme conditions.								
Wabash	32	**Governed by Special Orders.**								Special orders.
Norfolk & Western	30	At 30	50–100 ts	30–20	100–150 ts	20–10	200–250 ts	10–0	300–350 ts	Special orders.
Chi., Bur. & Quincy	*30	*30–0	10–15	*Below zero	15–20	†30–0	15–20	†Below zero	20–30	†‡10–15 per cent.
Chi., Mil. & St. Paul	30	30–20	5	20–10	10	10 to −10	20	−10 to −20	30	Special orders
Chi., St. P., Minn. & Omaha	30	30–10	10	10 to −10	15	−10 & lower	25			Special orders.
Great Northern	25	‡25–5	10	5 to −10	20	−10 & lower	25			Special orders
Chicago & North Western	20–25	Below 25	10–25							Special orders
Duluth & Iron Range	25	25–0	10	0 to −10	20	Below −10	25			Special orders.
Lehigh Valley	25	About 5 per cent. Reduction for each 10 deg. drop in temperature.								
Boston & Maine	15	15–0	7–15	1 to −15	12–18	−16 to −30	17−22			‡7–15 per cent.
Central Vermont	Zero	From zero to 35 degs. below reduce 150 tons for each 8 deg. drop in temperature.								Special orders.
Grand Trunk Pacific	Zero	0 to −5	5	−5 to −10	10	−10 to −15	15	−15 & lower	20	Special orders.
Intercolonial of Canada	Zero	Make reduction of 100 tons for temperature below zero.								Special orders.
Chi., R. I. & Pac.	Zero	20 per cent. reduction for below zero with no wind; 25 to 30 per cent. with heavy winds								‡10 per cent.
Denver & Rio Grande	Zero	0 to −10	10	−10 to −30	20					Special orders.
Colorado & Southern	Zero	0 to −25	10 to 25							Special orders.
Big Four		Governed by special orders.								Special orders.
N. Y., New Haven & Hartford		Matter left to division officers.								
Grand Trunk		Matter left to division officers.								
Pere Marquette		Bad storms and very cold weather, 20 to 30 per cent. reduction.								
A. T. & S. F. Coast Lines		No reductions except on Albuquerque Div., where reduction of 100 tons is made in winter.								Special orders.
A. T. & S. F. Eastern Lines		Governed by special orders.								Special orders.
St. Louis & San Francisco		Matter left to sub-division officers.								
Northern Pacific W. of Paradise, Mont.		Matter left to division officers.								
Southern Pacific		No reduction.								Special orders.
Kansas City Southern		No reduction.								Special orders.
El Paso & Southwestern		No reduction.								
Seaboard Air Line		No reduction.								Special orders.
Atlantic Cost Line		No reduction.								
Virginian		No reduction.								
Oregon Short Line		No reduction.								

* Light or no wind. † Heavy wind. ‡ Bad rail.

a position not radial with the center of the journal or front and back box covers permitting sand to be drawn into the bearings, may tend to increase the operating cost by reducing train tonnage; or increasing coal consumption and machinery wear.

The heavy train load up to a few years ago, was the goal of nearly all operating officers. It has never been accepted as advantageous on lines of dense passenger traffic where lightly loaded and fast moving freights not only keep out of the way of passenger trains, but earn more money by keeping out of sidings. Germany had the problem of the heavy train load before it and went back to the moderately loaded locomotive. England has never left the light, fast moving train. Congressional legislation in this country—the federal "hours of service" law, the "guaranteed mileage" to train employees in recent wage agreements, the demands and necessity for expeditious freight movement, the occasional inadequate car supply, and the heavy depreciation of equipment (both engines and cars) under heavy tonnage loading; these considerations are re-opening the question as to whether the excessively heavy "drag" train is really profitable. Mr. M. B. Wild, statistician of the Balto. & Ohio, concluded, after a series of investigations,[1] that slow speed implies great weight, a consumption of fuel and stores disproportioned to the gain in weight, and seriously rapid wear and tear and depreciation of implements; and decided that the economical freight train speed is between 15 and 25 miles an hour; and engines should be rated and loaded accordingly.

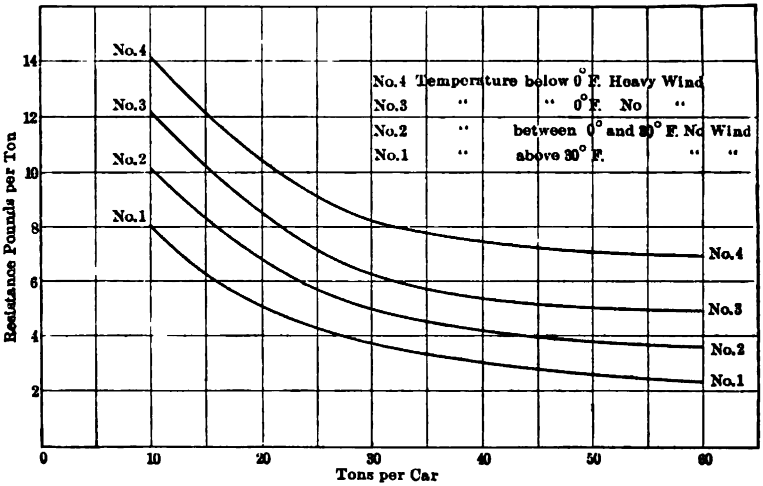

FIG. 48.—Resistance and temperature curves.

In its last analysis the question is one which might better be decided according to the conditions obtaining in each locality. Given a division of a hundred or more miles in length, with a heavy freight traffic and a comparatively unimportant passenger train service, and a ruling grade for a short distance—say 8 or 10 miles—opposed to the direction of predominating traffic. It would then undoubtedly be wise to load the engines to a comfortable working limit, with lever "down-in-the-corner" for the heavy grade, because it means 200 or more engine miles—figuring twice the length of the road—for every additional ton handled. On the same length of division with similar traffic conditions, with a greater part of ruling grade opposed to the direction of traffic—as for instance 40 or 50 miles out of a total 100, it would be unwise to load locomotives so heavily. A farmer, driving to market, will load his team to the utmost of its capacity if he has a short heavy grade in the entire distance, but with many such grades, and an equally heavy load, he would soon end the useful career of his horses.

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[1] See Railroad Gazette, Feb. 8, 1907.

On a line of extremely heavy passenger traffic, the loading of locomotives in freight service may not in any sense be dependent on the grades. It is short-sighted management to load freight trains to the dragging point when with less tonnage and added ability to start quickly they might almost continue over the division, in a short space interval between passenger trains. On such lines heavy freight trains may become side tracked for several hours at a time because of frequent passenger train movements, and because of their inability to get under headway when an opportunity is presented for a quick move. When the heavy cost of overtime under the high existing wage schedules is considered, and the expensive results of "tie-ups," under the federal hours of service law, the folly of heavily loading freight trains under such conditions is apparent. To estimate the extra expense in dollars and cents is difficult but it runs into large sums, in some cases amounting to $100 or $200 per hour. Then, too, delays are not only costly, but dangerous. One heavy passenger handling division of an eastern road has wisely directed that its freight trains be loaded so as to enable them to move and keep in advance of the average passenger train. On lines of this character much may be done in the way of simple and efficient signaling; improved siding connections and rearrangement of tracks; proper location of interlocking plants and correct location and design of stations, platforms, and adjacent tracks.

These features are given separate treatment in other chapters.

CHAPTER XI

TIME FREIGHT SERVICE

The railways of Great Britain lead in prompt and certain handling of high-class freight; their methods are described elsewhere. In point of speed for long distances, however, they have nothing to compare with the movement of perishable freight from the South to New York and Chicago, or with the package and perishable freight trains between Boston and New York and between New York and Washington; or with the 60-hours' movement of package freight between New York and St. Louis.

As distinguished from ordinary slow freight the fast freight service handles commodities, usually made up of package freight of an important or perishable nature, and almost invariably moving through freight-houses or piers for receipt or delivery. It is usually handled at higher rates and classified to have preference in this over common through and local freight. Among the reasons for the existence of this service are the necessity for quick marketing of high-class goods, which are manufactured on very close margins of profit to avoid the loss of the use of capital invested, and desirability of the jobber's carrying the smallest stock, with which he can meet the demand. It is not unusual for the merchant in New York City to telephone or telegraph the New England manufacturer two or three hundred miles away, for goods he expects to have on his counter the following morning, or for dealers in Buffalo at noon to order goods from New York which they expect to receive the following afternoon.

To operate fast-freight service successfully on the time allowed for transit and with reasonable certainty, it is essential that the prescribed speed be such as can be maintained with regularity. The capacity of the engine should be such as to enable it to make approximately the average speed, on the maximum grades. Careful inspections should be made to prevent other than the authorized commodities going in fast-freight trains. Cars traveling as fast freight should be readily distinguished by a card or mark on the side of car and on the card-bill.

Authorized fast-freight cars should be kept out of trains of ordinary freight. There should be a clearly understood arrangement with connecting lines for prompt and complete delivery of fast freight from or to such lines. Full information must be given as to the necessary icing or ventilating when needed. Notice of time live stock is to be loaded, fed and watered must be furnished and shown. Proper service at division yards should be arranged for gathering and distributing fast-freight cars so as to avoid stops of regular fast-freight trains, and the necessary preference should be given through terminals and in switching and changing of engines and cabooses. Full reports and records should be made of cars set out short of destination for any reason and prompt action should be taken to have them moved again. A full schedule for loading and moving fast freight from points between terminals should be planned and placed in the hands of all interested in the handling.

It is advisable to arrange for the smallest number of regular trains to be run, and add sections as required in preference to annuling schedules not wanted.

The time freight originating at Boston is handled by the Boston & Maine and New Haven roads, in trains made up in proper order; and the cars are so placed at the houses as to enable an immediate start, avoiding switching and accompanying detentions. The Boston & Maine places 120 cars at its No. 10 house at one setting. Freight is loaded up to within 10 to 30 minutes of leaving time, allowing time for closing doors, sealing cars and testing air. Transfer cars from nearby manufacturing towns are also handled in these trains. A running slip is made for each car and accompanies same to destination. Waybills are made up and forwarded by train mail, United States mail or express. Boston & Maine train 257 leaves Boston 3:30 p. m.; train 259 at 3:40 p. m.; arriving at Rotterdam at 1:20 and 1:30 a. m., respectively—a run of 212 miles in 9 hours and 50 minutes. New Haven symbol train B. H.–1,—commonly known as the "fish train"—leaves Boston 5:55 p. m. and arrives at Harlem River 1:50 a. m.—a run of 227 miles in 7 hours and 55 minutes.

The Boston & Albany runs two through fast-freight trains with cars destined beyond Buffalo; L.S.-3, with cars for Chicago and other points on or via the Lake Shore and Big Four roads and M.C.-3, made up of cars via Suspension Bridge for Chicago and points on or via the Michigan Central. These trains leave Boston (Beacon Park yards) at 8:00 and 8:30 p. m. respectively, passing Albany, 200 miles, at 6:45 and 7:45 a. m., the following day and arriving at Chicago, 1036 miles, at 6:30 and 8:15 a. m. of the third day out.

It is customary on some lines to designate fast-freight trains as "symbol trains." This is known as the symbol method. A combination of letters and numbers is used to indicate, in a general manner, the origin and destination of the train. The object is to preserve its identity among other trains. Where a schedule number is used over the entire line, the use of such numbers seems to answer all purposes and a number of large railroad companies follow this plan. Where the symbol method is used, the first letter of the symbol indicates the starting point where most of the freight is taken on. The second letter indicates the destination or the point where the train ends its run. Odd numbers in the symbol indicate west- or southbound and even numbers east- or northbound trains. On the Pennsylvania, as an illustration, assuming J to stand for Jersey City and P for Pittsburg, J P 1 would indicate a westbound train orginating at Jersey City and destined for Pittsburg. P J 2 would indicate an eastbound train orginating at Pittsburg and destined for Jersey City.

The symbol freight service, to be successful, must be handled very much like passenger service. The outgoing cars should be placed at piers or houses in such positions as practically to make up the train in book order when loading is completed. In some instances it may be necessary to "double" over onto two or more tracks because one track is not long enough to hold all the cars. At intermediate points and division terminals, these trains are not usually run into the regular classification yards, because being made up for final destination, it is only necessary at most to drop the station cars and take on those to be added. The cars to be dropped are probably at the head end and if engines are changed, the incoming engine holds onto these cars and sets them off. Cars to go from the station must be placed in the proper position in the train and if this would cause detention they are usually held for a later and slower train. When the final or system destination is reached the train may be pulled directly to and alongside the house into which the freight is unloaded, or, if stopped in the outlying or auxiliary yard, it is promptly moved to the unloading point by a yard engine.

First-class locomotives, adapted to high speed and in good condition, with picked crews, should be assigned to fast-freight runs when practicable. The symbol or working book should be placed in the hands of dispatchers, yardmasters, agents, conductors and others interested, and should give information in detail as to starting time of train, time at intermediate points, how cars are to be taken into trains along the line and how cars for various points are to be disposed of; movements to and from branch and connecting lines and arrangements for advance notice to divisions ahead.

The tonnage of the fast-freight trains should be closely watched to avoid overloading and consequent inability to make the necessary time.

Schedules should be worked out to arrange for picking up high-class freight along the division and for delivering freight at the intermediate points, with quickest possible dispatch and without requiring stops by the through fast-freight trains.

It is good practice to use a card bill of a distinctive color for cars to be moved on fast-freight trains. Some roads use a red card; others have a red stripe across the face of the card while others again use an ordinary card with a large red or black cross on its face. This quickly attracts the attention of the yardmaster, conductor or agent, and there is less likelihood of the car going astray or becoming indefinitely side-tracked in some "pocket."

Yardmasters should have advance information of the make-up of an approaching fast-freight train and the number and location of cars to be taken out of the train, to enable prompt handling and to have cars to fill out in readiness.

Fast freights should be made up in proper order and all cars added should be placed in their proper positions to avoid delay along the line in switching. Airbrake cars only should be loaded for these trains, and cars should be carefully inspected and in good condition before starting.

It is estimated generally that "live stock, perishable and merchandise" include about 10 per cent. of the entire freight traffic; 30 per cent., however, will be the proportion when the high-class freight at higher rates is added. It would be interesting to know the cost of handling fast freight in excess of ordinary freight but, unfortunately, accurate statistics on this point are hard to obtain. Some carefully conducted tests were made some years ago on the Northern Pacific and records kept of the cost of moving trains at various speeds.

On the Minnesota Division, westbound, at a speed of 15 miles per hour with an engine developing 400 h. p. and hauling 1050 gross tons, the cost per train-mile was 60 cents. At a speed of 20 miles per hour the tonnage fell to 949 tons and the train-mile cost went up to 68.6 cents. At a speed of 35 miles per hour, it cost four and one-half times as much to move an equivalent tonnage as at 15 miles per hour over this particular division of road. Additional track maintenance, loss of time to ordinary and local freights in clearing the line for fast freights, are some of the elements of cost which are not included in the above figures.

Another interesting and instructive series of records was kept to collect data on the relative economy of running slow freight-trains with engines loaded to maximum capacity, compared with fast-freight trains of less than the maximum capacity of engines, on the Indiana Division of the Baltimore & Ohio Southwestern during the months of January and February, 1904. The records and results were as follows:

First.—For common freights scheduled to travel about 9 miles per hour, ating being assumed as full capacity of engine for this speed.

Second.—For semi-quick dispatch freights, it being intended that this class of freight should make an average schedule speed of 15 miles per hour, rating of engines being assumed at 72 per cent. of rating for common freights.

Third.—Quick dispatch freights, it being intended that this class of freight should make an average schedule speed of 19 miles per hour, rating of engine being assumed at 60 per cent. of rating for common freights.

The data collected for each of these classes of trains for separate trips were as follows:

1. Temperature.
2 Number of engines.
3. Number of cars.
4. Number of 1000 ton-miles, no arbitrary allowance being included.
5. Running time between terminals.
6. Rate per hour, running time between terminals.
7. Total time between terminals.
8. Rate per hour, total time between terminals.
9. Cost of operation.
10. Cost of fixed charges.
11. Total cost.
12. Cost per 1000 ton-miles.
13. Per cent. hauled of the maximum rating for common freight.

The "cost of operation" for each trip was obtained from actual cost of wages, overtime, cost of helper engine and fuel, as shown by records of that trip; the number of engine-miles per trip multiplied by the total cost per mile, as shown by monthly records for the following items; running repairs, classified repairs, oil, sand, waste, miscellaneous engine supplies and roundhouse attendants, which amounts to 14 cents per mile for the 1500-class engines and 8 cents per mile for the 100-class engines.

The average original value of the 1500-class engines was estimated at $11,000 each and that of the 100-class engines at $9000 each. An annual allowance of 5 per cent. on the value should be made for interest and 5 per cent. for depreciation, making a total of 10 per cent. per annum. In order that the use of an engine may be justified, it must earn 10 per cent. per annum on the capital invested, and must for each hour of its time be worth a proportionate amount to the railroad company. For the 1500-class engines this would equal about 12 cents per hour and for the 100-class engines 10 cents per hour. This is the fixed charge made against each train for each engine for each hour in transit. The average value of a freight car was assumed to be $800, and on the same basis a car, in order that its use may be justified, must earn 10 per cent. of its value per annum, which would amount to 1 cent per hour. On this basis the fixed charges for the train equipment for any trip would be 1 cent multiplied by the number of cars in the train, multiplied by the number of hours between terminals; plus $0.12 or $0.10 multiplied by the number of engines, multiplied by the number of hours between terminals.

The per cent. of rating handled by each train was obtained from a tonnage statement, by dividing the actual ton-mileage made by the ton-mileage which would have been made had maximum common freight rating, corrected for temperature, been used.

The "total cost" used does not represent the actual cost of handling the train between terminals, but includes only those principal items which vary with, or are dependent upon, each trip. The cost obtained by dividing the total cost by the number of 1000 ton-miles is therefore correct for comparative purposes only.

The above data have been shown graphically on the diagram (Fig. 49) as follows:

First.—A chart has been made by plotting the actual running time in miles

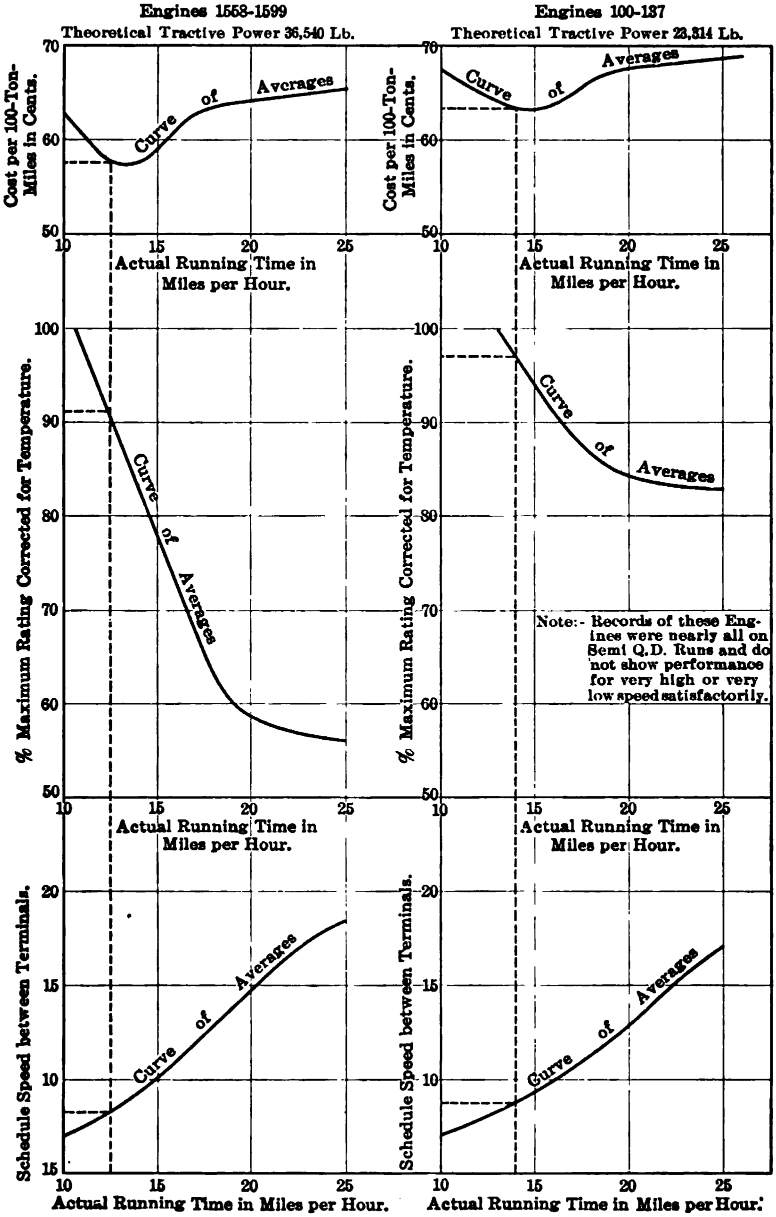


FIG. 49.—"Curves showing relative economy of train loading.

per hour on the horizontal ordinate and the cost per 1000 ton-miles on the vertical ordinate. The curve of average results indicates the cost per 1000 ton-miles corresponding to given speeds in actual running time.

Second.—A chart has been made by plotting the actual running time in miles per hour on the horizontal ordinate and the percentage of the maximum rating for common freight on the vertical ordinate. The curve of average results indicates the percentage of maximum rating which must be given trains in order that their average speed may be a certain running time in miles per hour.

Third.—A chart has been made by plotting the actual running time in miles per hour on the horizontal ordinate and the time between terminals in miles per hour on the vertical ordinate. The curve of average results indicates the relation between the actual running time and the schedule speed in miles per hour between terminals.

From these charts we may see graphically the comparative cost of fast and slow freight service and to a certain extent the relative economy of heavy and light motive power. When it is desired to move freight between given points on this division in a fixed time it will be possible from these diagrams to determine the rating which must be given engines in order that they may make the desired schedule.

For the 1500-class compound freight engines the minimum cost is found at a speed of 13 miles per hour, which requires a rating of 88 per cent. of the maximum; but a speed of 12.5 miles per hour does not increase the cost of handling appreciably and will allow 91 per cent. of the maximum rating to be hauled. By referring to the third chart it appears that an actual running time of 12.5 miles per hour corresponds with a schedule speed of 8.25 miles per hour between terminals.

For the 100-class engines the minimum cost is shown at a speed of 15 miles per hour, which requires a rating of 94 per cent. of the maximum; but a speed of 14 miles per hour does not increase the cost of handling appreciably and will allow 97 per cent. of the maximum rating to be hauled. It also appears that a running time of 14 miles per hour corresponds to a schedule speed of 8.75 miles per hour.

From the conditions existing when these records were taken, we should conclude that for the 1500-class engines the most economical operation will be attained by trains scheduled at 8.25 miles per hour, running 12.5 miles per hour and hauling 91 per cent. of maximum common rating. For the 100-class engines the greatest economy of operation will be attained by trains scheduled to 8.75 miles per hour, running 14 miles per hour and hauling 97 per cent. of maximum common rating.

The records of about 500 trains given above were taken during a period of exceptionally heavy traffic and also during unusual severe weather, with the temperature in the neighborhood of zero for weeks at a time. It is probable that results in warm weather would be different. It would, therefore, be desirable to make the same determinations under summer conditions. The determination of the most economical tonnage rating by this method is independent of the rating originally assumed.

The fast freight proposition, divested of all questions of politics and policies, resolves itself into "charging what the traffic will bear"—or of furnishing the service which the character of the freight and competition demand; and to determine this, the cost of handling it, on fast time, is important.

Mr. George R. Henderson gives some valuable data in his "Cost of Locomotive Operation" from which the following is quoted:

"The cost per 1000 ton-miles for all combinations of speed and train load, computed:

Speed up hill, miles per hour	5	10	15	20
Weight of train, tons back of tender	2,550	2,530	1,900	1,350
Ton-miles per trip, back of tender	383,000	380,000	285,000	202,000
Running time, hrs. bet. terminals	17.5	10.0	7.5	6.25
Actual time, hrs. bet. terminals	21.0	12.0	9.0	7.5
Average speed, between terminals	7.2	12.5	16.7	20.0
Cost, per 100 0ton-miles, net	$0.36	$0.37	$0.39	$0.43
Million ton-miles handled per month	10.6	16.1	14.7	11.6

With reduced train loads, cost and ton-mileage is as follows:

Speed; miles per hour	5	10	15	20	25	30
400 tons (back of tender)	1.60	1.11	1.05	1.10	1.15	1.25
	1.05	1.87	2.54	3.08	3.54	3.92
600 tons	1.21	.90	.85	.91		
	1.58	2.81	3.81	4.63		
800 tons	1.00	.78	.79	.86		
	2.11	3.76	5.08	6.18		
1,000 tons	.89	.72	.76			
	2.63	4.70	6.35			
1,200 tons	.82	.70				
	3.16	5.63				
1,400 tons	.79	.75				
	3.69	6.57				

The upper set of figures represent cost in dollars per 1000 ton-miles and the lower figures, million ton-miles handled per engine per month. A speed of 10 to 15 m. p. h. seems the most economical and moves the greatest tonnage in a month with the heavier loading. With lighter loading a higher average speed becomes necessary to accomplish as much in the same time period.

CHAPTER XII

TEAM DELIVERY YARDS

The general location of team yards should be as near to the industrial scenter of the city as practicable. If there is tide-water competition this is particularly desirable, as an additional team haul of a few city blocks will often be the deciding factor in routing the freight. The competition of other railroads in a smaller degree is more readily met by a central location. Those responsible for securing railroad traffic usually favor the location most convenient to the shippers.

On the other hand, consideration should be given to the higher taxes and interest charges on the more valuable real estate occupied by the central location. The problem is to ascertain whether the central location will bring sufficient additional traffic to justify the higher fixed terminal charges; or, to put it in another way, how much business the road can afford to lose while availing itself of the lower fixed charges of a terminal in a less central and less expensive location. This feature is discussed somewhat in detail in Chapter III.

The location of team yards with reference to other facilities is of more direct interest to those having to do with the operation of the road. Obviously they should be as convenient to the freight-houses as practicable. This will enable the freight agent's force to supervise the loading and unloading of freight and arrange the car supply more readily, as cars made empty in the team yards and not required for immediate outward loading, may readily be transferred to the houses, or *vice versa*. If the team yard is near the freight-house, it is satisfactory to the patron because a teamer taking a load to the freight-house may get a return load from the team yard, or in going to the team yard, return by way of the inbound house.

The contour and track spacing of a team yard depends upon the size of the property available and such property, because ordinarily so close to the city's business center, is rarely adapted to an ideal layout. A number of tracks each holding 10 to 15 cars, are preferable to fewer tracks of greater length, but property restrictions usually determine which shall be used. The shorter tracks tend to quick handling and permit cars to be placed with the least interference to draymen. A capacity of 12 to 15 cars per track may be considered the maximum economical length. To save space they may be laid in pairs, similar to repair tracks, and as a matter of safety in working around teams and draymen they should be single-end connected. This gives more available track space than where ladders are put in at each end of the yard. An acute angle—as abrupt as 60 degrees—between the ladder tracks and the body (team delivery) tracks, may be permitted to increase the length of the team track alongside of which there may be sufficient width of roadway for unloading and loading purposes. Close spacing between each pair of tracks—11 ft. 6 in. or 12 ft. center to center of track—is advisable. For the roadway, a space of as much as 48 ft. center to center of track, giving about 40 ft. clear width for team use, is advantageous. This gives a full width of roadway for teams, when both tracks are filled with cars, and as the width of the ordinary wagon does not exceed 6 ft., although some motor tracks are more than 8 ft. wide, the space is ample to enable teams to stand backed up to cars in each track with wagon poles turned at right angles to the body of wagon. With the increasing use of motors for trucking it is found that less roadway is needed than with teams, although the motor trucks are built considerably larger than the drays.

To determine the proper width of driveways and to ascertain the effect of the increasing number of motor trucks, actual measurements were taken at Providence, R. I., of trucks and drays as they arrived, Sept. 1, 1911, with the following results:

Inbound freight-house No. 1—20 vehicles. Maximum length, 33 ft. 4 in.; minimum length, 10 ft. 10 in.; average length, 22 ft. 5 in. There were five trucks exceeding 30-ft. length. Width: maximum, 8 ft. 5 in.; minimum, 6 ft. 1 in.; average, 7 ft. 2 in.

Inbound house No. 2—20 trucks. Length: maximum, 26 ft. 10 in.; minimum, 14 ft. 10 in.; average, 19 ft. 10.5 in. Width: maximum, 8 ft. 6 in.; minimum, 6 ft. 2 in.; average, 7 ft. 0 in.

Outbound house No. 3—30 trucks. Length: maximum, 33 ft. 9 in.; minimum, 13 ft. 0 in.; average, 21 ft. 0.3 in. (6 trucks exceeded 30 ft. length. Width: maximum, 8 ft. 2 in.; minimum, 3 ft. 10 in.; average, 7 ft. 5 in.

Team yard No. 15—15 trucks. Maximum length, 31 ft. 5 in.; minimum, 13 ft. 6 in.; average, 23 ft. 2.5 in. Maximum width, 8 ft. 2 in.; minimum, 6 ft. 6 in.; average, 7 ft. 2 in.

In each case the length was measured to cover the space the truck would occupy if standing at right angle to a house or car.

In establishing a width of driveway for team yards, some designers figure on using multiples of the adopted track center. Assuming 12 ft. centers to be used, the width of driveway would, under this method, be made 36 or 48 ft. center to center of track. If a 48-ft. center to center driveway is used and tracks are laid in groups of two paralleling, as is customary, it would be practicable afterward to put in a third track, establishing groups of three—one center or "dead" track not accessible

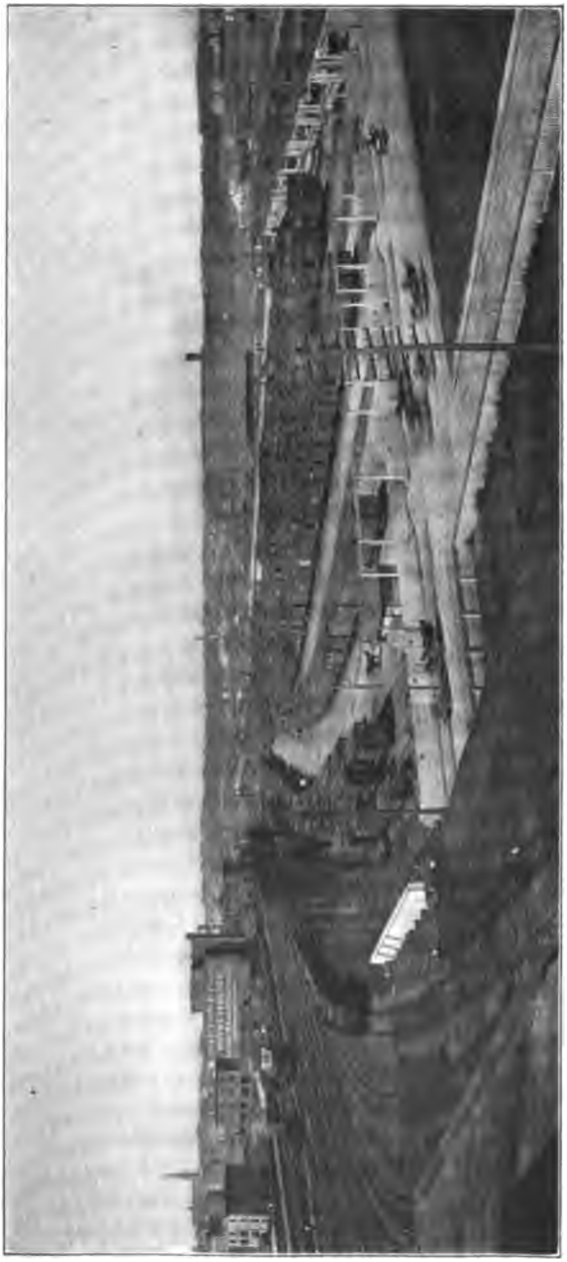


FIG. 50.—Gaspee Street team delivery yard, Providence, R. I.—New York, New Haven & Hartford.

to teams—and still leave a 36-ft. center to center driveway. This system of using groups of three tracks is in effect in yard 17, at Providence, a cut of which appears in Fig. 50. Should it be desired for any reason to abandon the yard for team delivery purposes and use it as a storage or classifying yard, additional tracks—to the extent of two on a 36-ft. center, three on a 48-ft. center—may be laid without disturbing those already in use. This has been discussed in Chapter IV.

Track scales should be provided and located where convenient for switching, preferably on the principal lead track to avoid reverse or additional movements in weighing cars going to or coming from the loading and unloading points. Unless all cars are weighed the scales should be provided with "dead tracks" to avoid the necessity of running over the scale machinery unnecessarily. This subject is more fully discussed elsewhere.

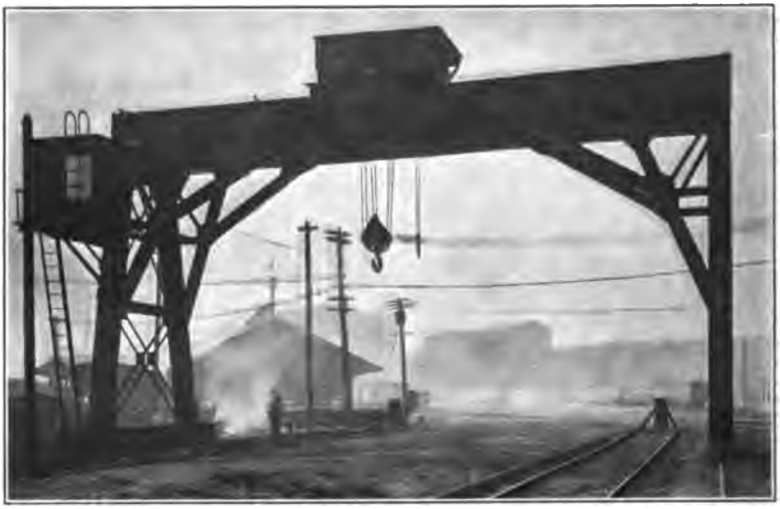


FIG. 51.—Typical freight transfer crane.

Wagon scales should be located where teams may readily reach them without obstructing the driveways, and where the greater part of the freight to be weighed on teams is handled, if cars for such freight are separately placed.

Transfer cranes are ordinarily located at the entrance of the yard and at the point most accessible to teams with heavy pieces of freight. A crane operated by power is desirable in large yards. If very much bulky or heavy freight is handled, it may be well to have both a heavy capacity crane and a lighter one. These appliances greatly facilitate the release of cars. A good arrangement is a bridge crane, with a trolley on top, covering one track and the adjacent roadway. The crane may be operated by hand or electric power. The one shown in Fig. 51 is typical of a crane in general use.

The gantry type of crane is arranged not only to transfer a piece of freight from wagon to car or car to wagon but may also move freight from one car or team to another car or team. A typical gantry is shown in Fig. 52 by which the Balto. & Ohio unloads 40 cars without making a switch or moving a car.

In its 12th Street yard, Chicago, the Balto. & Ohio has a heavy gantry crane. The main hoist has a capacity of 23 tons; the auxiliary 5 tons. Its motors are operated by 500-volt current. The gantry has a width of 42 ft. center to center of ground rails, and spans a wide team driveway with a track on each side. Twenty-four cars may be covered without moving them.

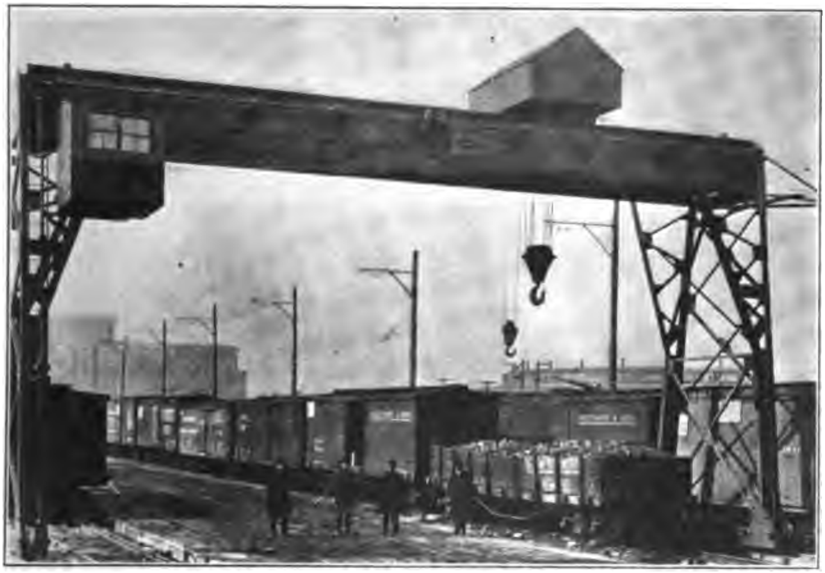


FIG. 52.—Electric power crane—Baltimore & Ohio.

The type of crane shown in Fig. 53 is built for sturdy work and possesses great flexibility. The one shown in the cut is located at 12th Street, Chicago—Lake Shore and Michigan Southern—and covers four tracks and three driveways, accomodating 25 cars at one placing. It is electrically operated and has a lifting capacity of 25 tons.

The Lake Shore also has a gantry at Cleveland, Ohio, with two hoists; one of 30 tons capacity and the other—an auxiliary—of 5 tons. Two sidetracks and a driveway are covered. Electric power is used, and the annual cost for current is estimated at $500. Thirteen gantry loads have been handled in 20 minutes. One operator is employed; the hoist being attached to the load by the teamers.

Inclines running from the roadway to the car-floor level at the end of a track, are advantageous, especially where heavy machinery on wheels, agricultural harvesters, threshers, mowers, traction engines, fire engines and the like are to be handled. The same result has been obtained by depressing the end of a track so the floor level of a car on the depressed track will be on a level with the roadway.

Ramps or inclined driveways crossing team yards or tracks should be avoided, but in securing locations near centers of cities, particularly where these yards are contiguous to streets where grade crossings have been abolished, ramps become unavoidable. Grades on driveways exceeding 2.5 to 3.5 per cent. should not be used. Where turns are necessary, they should be made level if possible, or at most not to exceed 2 per cent. By building the yard on a grade of from 0.5 to 1.0 per cent., ramps can sometimes be avoided or decreased in length. The grade of tracks in a team yard should not exceed 1.0 per cent., and even this may be deemed excessive because of the opportunity for accident, through rough switching.

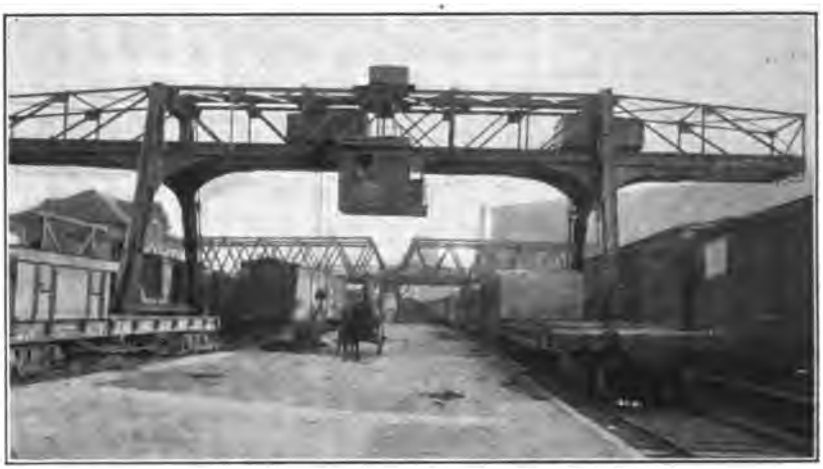


Fig. 53.—Electric traveling crane, Chicago—Lake Shore & Michigan Southern.

Bumping posts are expensive to install and maintain. Where the failure to stop a car at the end of the track is not liable to result in serious consequences, a piece of timber or a mound of dirt may serve the purpose. Occasionally these are objected to because of their appearance not conforming to surroundings. Where the ends of tracks abut on streets or sidewalks with considerable travel, or where they end close to buildings which might be seriously damaged, the risk of such damage and personal injury to pedestrians and others justifies the installation of some approved type of bumping or buffer post.

The roadway should be well paved and ample drainage provided to permit and encourage unloading during wet and stormy weather. This is particularly desirable under the demurrage rules which do not permit the assessment of demurrage during inclement weather. It is advisable to plank or pave the tracks or the ladder if the yard is so located as to make it necessary to drive across them.

The kind of paving to be used depends upon the character of commodities principally handled and the character of the subsoil and is based on the average weight of the dray with its load—whether 3, 6, 8 or 10 tons, on four wheels. Stone flagging will cost from 15 to 30 cents a square foot; asphalt 15 to 30 cents; stone paving 25 to 40 cents. A good gravel with a heavy top dressing of crushed trap rock—something on the order of macadam—makes a good driveway, much cheaper and equally durable where the traffic is not heavy. The average two-horse truck is supposed to be able to haul, on a level on good roads, a load of 9500 lb. including the weight of the wagon. One of the New York ferry companies weighed about 200 trucks some time, ago and found the average weight 16,000—and at times as high as 20,000 lb. gross each. It is difficult to keep driveways in good shape under such loads unless the pavement is well drained and has a good foundation.

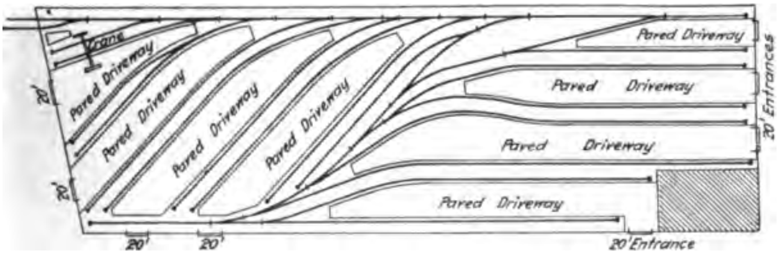


FIG. 54.—Lehigh Valley freight yard at West 27th Street, New York.

Typical team delivery yards in actual use are always interesting, and it is noteworthy that extensive ones recently constructed are without material change over existing ones. This is due more to the necessity for conforming to physical and property limitations than the usual acquirement of knowledge as to the needs. A good freight delivery yard getting the most out of a very valuable piece of property is that of the Lehigh Valley at West 27th Street, New York, shown in Fig. 54.

Figure 50 shows the team delivery yard of the New Haven at Gaspee Street, Providence, R. I., which has a capacity of 675 cars, of which 458 can be placed accessible to teams, the remaining 217 on so-called

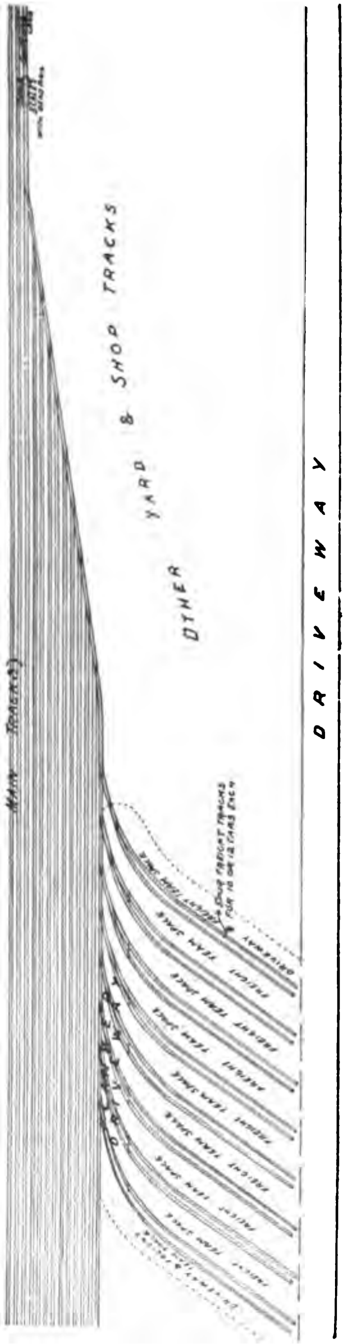


FIG. 55.—Plan of team yard suggested by Mr. F. H. McGuigan.

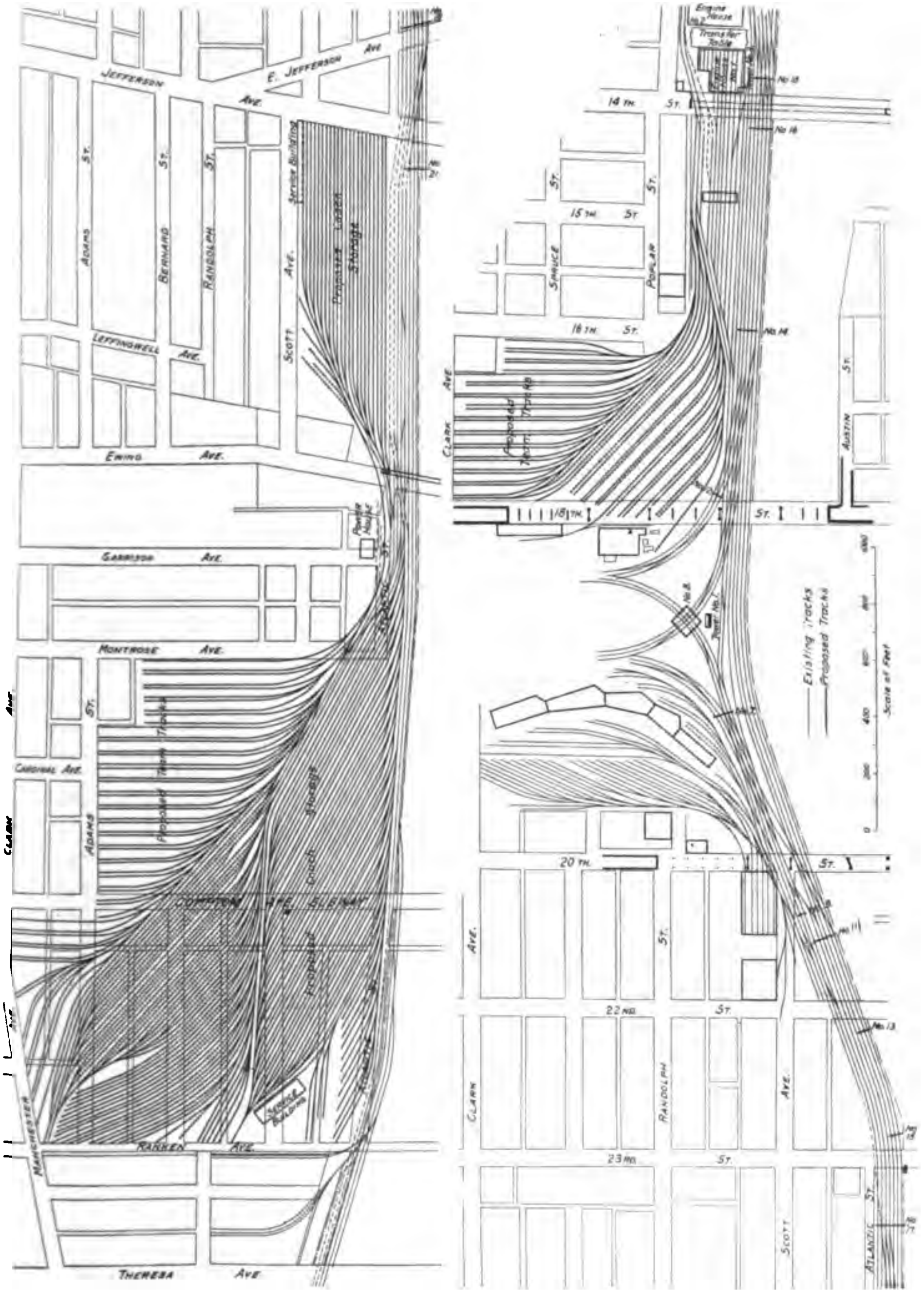


FIG. 56.—St. Louis Terminal improvements.

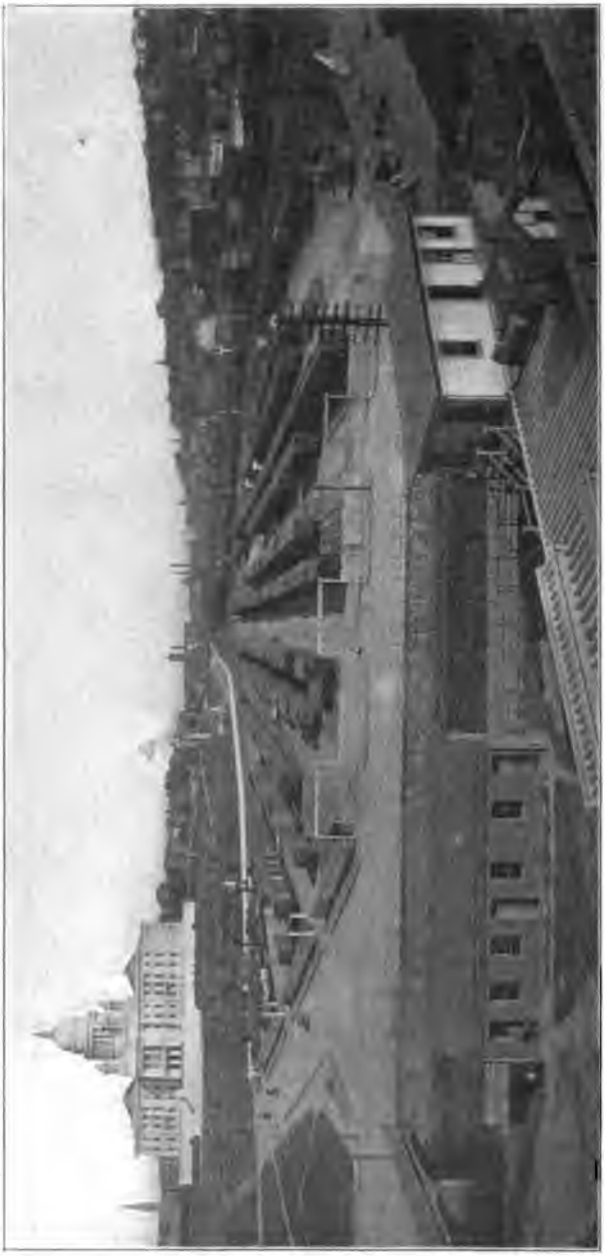


FIG. 57.—Perishable freight delivery yard. Providence, R. I.—New York, New Haven & Hartford.

"center" or dead tracks. The yard occupies 21.8 acres of land and consists of 26 tracks ranging in length from 400 to 1600 ft. In some cases groups of three tracks parallel are laid instead of two. The center track is then not accessible to teams, but cars thereon may be unloaded through the doors of cars on outside tracks. Ordinarily these "center" tracks are used to hold empties, to be placed for loading or on which to make up drafts of cars to go out—loaded cars or empties which were unloaded. In the Gaspee Street yard driveways are 48 ft. wide center to center, and tracks are laid to 12 ft. centers.

In the sketch of a yard by Mr. F. H. McGuigan (Fig. 55) presented to the Railway Engineering and Maintenance of Way Association, a car may be put on or taken from one point or any track without disturbing any considerable number of teams loading or unloading cars on the same track, and it has the advantage of utilizing a short square piece of ground available for only two or three short parallel tracks.

The St. Louis Terminal Association has team tracks at 13 places with room for 1123 cars, and anticipates immediate need for double this capacity. An acre of land will enable placing of 25 cars for team delivery. Estimating cost of the land at $200,000, with interest at 4 per cent., and the prevailing rate of taxes on one-half the cost of the land, the charge on each car for land interest and taxes would be $3.81, assuming that the car occupied the track three days, not counting Sundays and holidays. The plan shown in Figure 56 shows the proposed team yards of the Association in St. Louis.

Figure 57 shows the New Haven's Stillman Street yard at Providence, R. I., with a capacity of 440 cars, of which number 311 can be placed accessible to trains. A large power crane may be seen on the left. This yard is used for handling fruits, meats, vegetables and other perishable freight. Driveways are 43 ft. center to center; tracks spaced to 12 ft. centers. Ten acres of land are covered; there are 33 tracks, in groups of three parallel, each being from 400 to 600 ft. long.

CHAPTER XIII

LIVE STOCK HANDLING

In 1827, there passed through a turnpike gate on the Cumberland river 105,517 hogs on the way to the South Atlantic states. During the five years 1847–1852, one man drove 13,000 sheep from Vermont to Virginia. In 1884, about 416,000 head of cattle were driven from the southeast to northern ranges. With the opening of the railways, the driving was reduced and the time in transit reduced to days instead of months. One of the first rail cattle shipments, consisting of 100 head, Cincinnati to New York, occurred in 1852, having first been driven from Lexington. They were carried in cars from Cincinnati to Cleveland thence by steam-boat to Buffalo; then driven to Canandaigua; moved in cars to Albany; and from there taken by boat to New York. The freight charge was $120 per car, Cincinnati to Buffalo; the total expense, Lexington to New York, $14 per head.

The present average annual receipts of cattle at Chicago are upward of 3,500,000 head; Kansas City, 2,500,000; St. Louis, 1,500,000 and Omaha, 1,200,000. Chicago receives 8,000,000 hogs and 5,000,000 sheep annually. The Union Stock Yards, Chicago, cover 500 acres and have 13,000 enclosures; they will hold 75,000 cattle, 125,000 sheep, 300,000 hogs and 6000 horses at one time. There are facilities for unloading 60 cars per hour. The yardage cost for cattle averages 25 cents per head; calves 10 cents, hogs 8 cents, sheep 5 cents.

Between southern Idaho and Omaha, cattle have ordinarily to be let out of cars three or four times, to be fed and rested; between Omaha and Chicago, once; and between Chicago and Boston or New York, once.

About 25 head of cattle are loaded into a car; 75 hogs into a single-deck and 240 sheep into a double-deck car. Cattle weigh 950 to 975 lb. each.

Intelligent location and construction of terminal and way pens will enable much time to be saved in the handling of live stock. Stock may have been in transit approaching the 28-hour or the 36-hour limit and it becomes necessary to reach unloading pens quickly. The location should be convenient to the receiving yard and at a point where cars may be run in with a minimum of interference. Proximity to source of feed and water supplies is also essential.

Where the business runs heavy, tracks fronting the yards, long enough to hold an average train without cutting it in two, are preferable, as it is

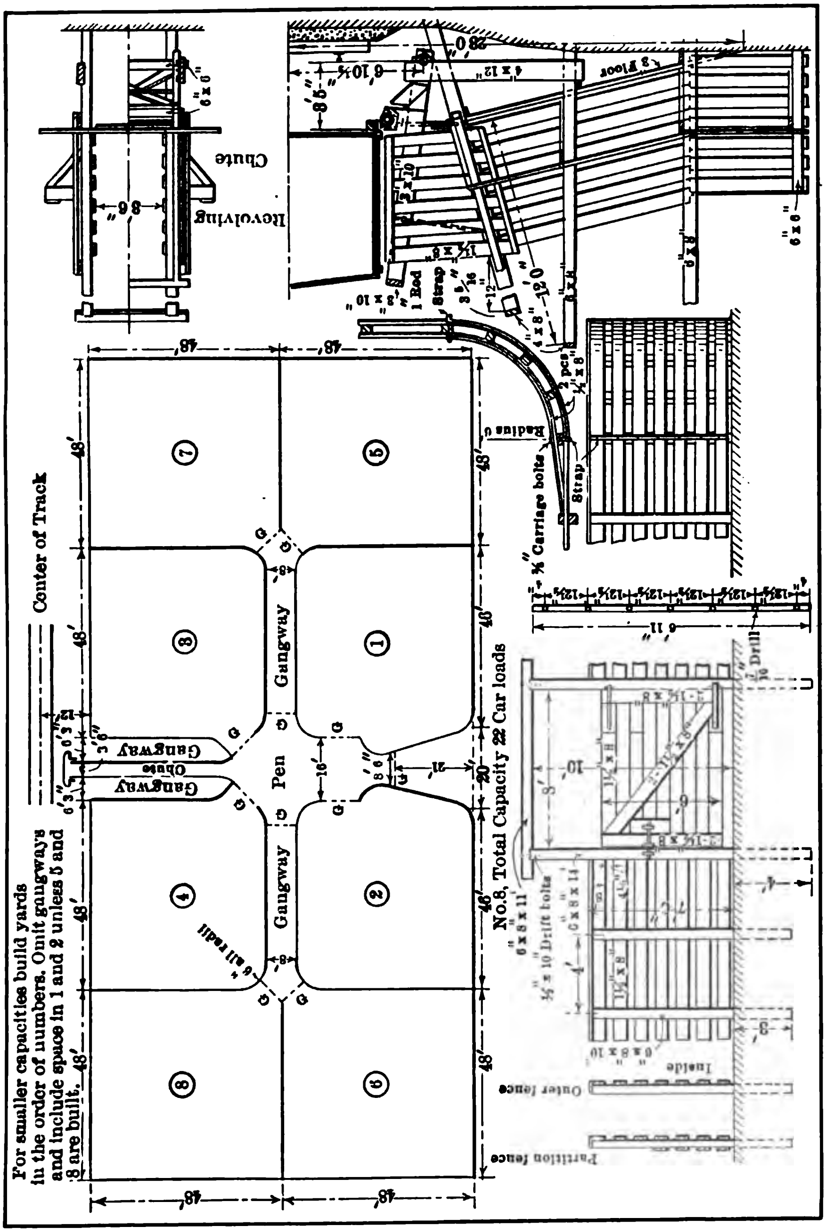


FIG. 58.—Plan of typical far western stock corral.

objectionable to couple or uncouple cars in stock trains because of the added opportunity for injury to stock. For smaller business, fewer pens would be provided and correspondingly shorter unloading tracks. The unloading platforms run alongside of the track, with fences on the track side containing gates and runways to the penside, with adjustable chutes to reach the upper decks of double-deck cars. Swinging gates are ordinarily arranged to be thrown across the long unloading platform, acting as movable runways from the pens to the car, or *vice versa*. A system of continuous gates alongside the cars, to enable an opening to be made opposite any car door, is desirable and usually planned in all larger layouts. This makes it unnecessary to "spot" cars and avoids coupling and recoupling for that purpose.

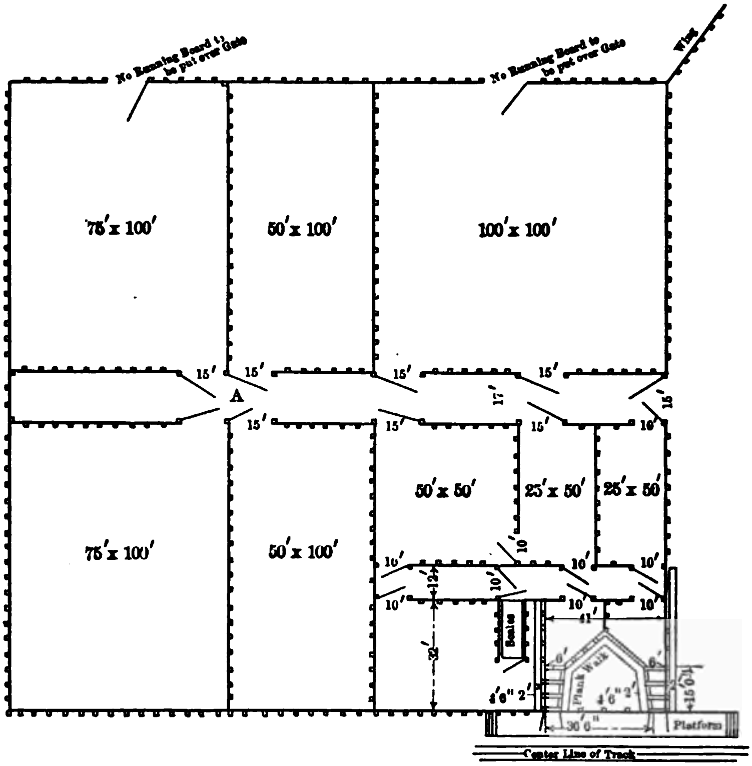


FIG. 59.—Plan of stock pen, chute, platform and scales.

The plan shown in Fig. 58 is that of a typical far western stock "corral." This is arranged for any number of pens and readily permits additional pens to be attached. A small stock pen about 30×48 ft. will cost approximately $45 for labor; $60 for material, a total of $105.

The drawing in Fig. 59 is of a stock yard 200×225 ft., nine pens, two alleys, two chutes, with platform and stock scales. In Fig. 60 are shown a portable chute, a chute with swinging gate to match with car doors; and platform.

A two-pen stock yard should cost about $180 divided equally between labor and material; a four-pen about $340 and additional pens in the same ratio.

There is no class or character of freight handled by railways that is more susceptible to heavy losses, real or imposed, than live stock. It is a debatable question whether the profits thereon justify the movement at the rates in effect. The so-called professional stock-trader usually accompanies the shipment and carefully notes every case of air-brake application; and if the market is not all to his liking he makes his claims against the transportation company for loss in value. Reparation is then asked on grounds of rough handling, detentions and other alleged irregularities to compensate the owner for loss or shrinkage due to bad condition of stock, diseases or improper or insufficient food.

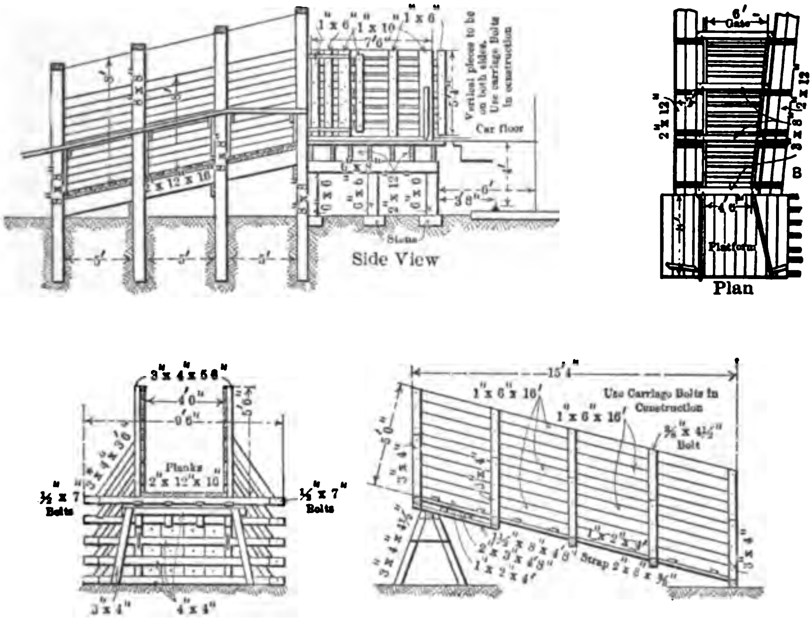


Fig. 60.—Details of portable stock chute.

Special yards must be provided; high-speed trains run, with their accompaniment of low train load and interference to other traffic; specially constructed cars, which can be used for but little beside stock, consequently running empty in one direction; special facilities for loading and unloading; and preferred handling in yards. The various agents of the

Society for the Prevention of Cruelty to Animals are usually well-meaning and sincere, but in many instances, actuated by political motives or moved by heartrending stories of disgruntled railway employees and live stock attendants, entail unnecessary cost and actual injustice on the railways.

The railways pay from 50 cents to $1 per car for loading live stock, and a similar amount for cleaning cars. During hot weather they have to arrange for spraying with cold water at different points, entailing another expense of perhaps 25 cents per car. An attendant is carried free with each two car loads and is returned free. One stock-carrying road estimates its damage claims at an average of $1.61 on each car handled. This road puts the average cost for construction of stock-pens for loading at $1422 each—and when paved, $1000 additional.

The federal law relating to feeding, watering and resting cattle, approved June 29, 1906, provides that "cattle, sheep, swine or other animals" shall not be confined in "cars, boats or vessels of any description for a period longer than 28 consecutive hours without unloading the same in a humane manner, into properly equipped pens for rest, water and feeding, for a period of at least 5 consecutive hours, unless prevented by storm or by other accidental or unavoidable causes which cannot be anticipated or avoided by the exercise of due diligence and foresight; provided, that upon the written request of the owner or person in custody of that particular shipment, which written request shall be separate and apart from any bill-of-lading, or other railroad form, the time of confinement may be extended to 36 hours." It also stipulates that the time consumed in loading and unloading shall not be considered in estimating the confinement and it does not require the unloading of sheep during the night; and when the time expires during the night, in case of sheep, they may be continued in transit to a suitable place for unloading, subject to the limitation of 36 hours. Animals so unloaded shall be properly fed and watered during such rest either by the owner or person having custody thereof; and in case of his default, by the transportation company at the owner's expense. "When animals are carried in cars, boats, or other vessels in which they can and do have proper food, water, space and opportunity to rest, the provisions in regard to their being unloaded shall not apply." The penalty is $100 to $500 "for every such failure"—which probably may be interpreted to apply to "each carload" rather than to each train load or each separate shipment.

Hogs are liable to suffer during warm weather and should be sprayed ("slushed") with cold water on the appearance of the first warm weather, and troughs should be kept filled. Shippers usually ask that they be sprayed as soon as train stops and that train be kept moving when practicable. They should never be sprayed after having been allowed to stand in the hot sun for any length of time, having become heated.

Water on heads of hogs under such conditions is liable to kill them. Neither should they be sprayed during the night, as this abruptly awakens them from a quiet sleep and is detrimental.

A car designed with drop bottoms, for stock, coal, coke, etc., is shown in plan of underframe, side elevation and perspective, in Figs. 61, 62 and 63. The floor consists of 12 drop doors, which, when closed, form a flat bottom. They are hinged near the center line of car and fall away from the sides and are operated from a platform on the end of the car by turning a hand wheel on the vertical shaft. There are two of these operating wheels at each end; each operates three doors, or one-quarter of the whole number. It is claimed that this car is perfectly safe as a stock car and that after the seal is broken, by simply turning the hand wheels, the whole bottom can be dropped. Obviously the advantage in operating a successful car of this type lies in its adaptability to live stock service and coal, coke or ore, and the fact that live stock generally moves eastward, while coal and coke move in the opposite direction, thereby enabling a greater percentage of loaded car-mileage to be obtained.

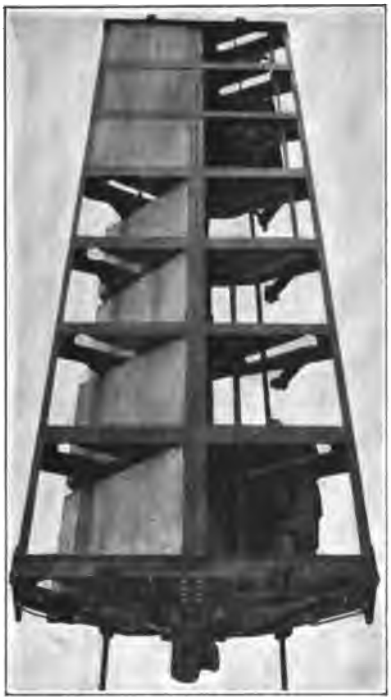


Fig. 61.—Underframe of drop-bottom convertible stock car.

At times, too, great stress is laid on high speed and heavy train tonnage in the transportation of live stock, without weighing with sufficient care, the loss resulting through claims for injury. Fast, heavy freight trains are incompatible with smooth handling. Trains of live stock should be made up solid—that is, wholly of live stock—when practicable, and only sufficient tonnage to enable the engine to almost maintain the average schedule speed on ascending grade sections to permit of an approximately uniform speed. The train dispatcher should endeavor to keep this train on the main track, avoiding stops and arranging for such stops as must be made, at points where the train may be comfortably started, and without taking the slack. More than ordinary care should be given airbrakes on stock cars to keep triple valves particularly well cleaned and oiled to prevent so-called "kickers" from throwing the brakes into emergency when not intended, and to keep piston travel of brake cylinders adjusted, so each car will do its part, and only its part, in retarding the movement of the train. When it is necessary to fill out a train of live stock with other freight, such freight should be put in the rear, to reduce the liability of shock in brake applications when stopping. Engines and enginemen should be selected for this service to give smoothest possible handling consistent with speed requirements. It has seemed to the writer that the speed question is frequently overdone in live-stock handling and that is perhaps due more to over-zealousness of the traffic departments to secure a "talking point" than to any

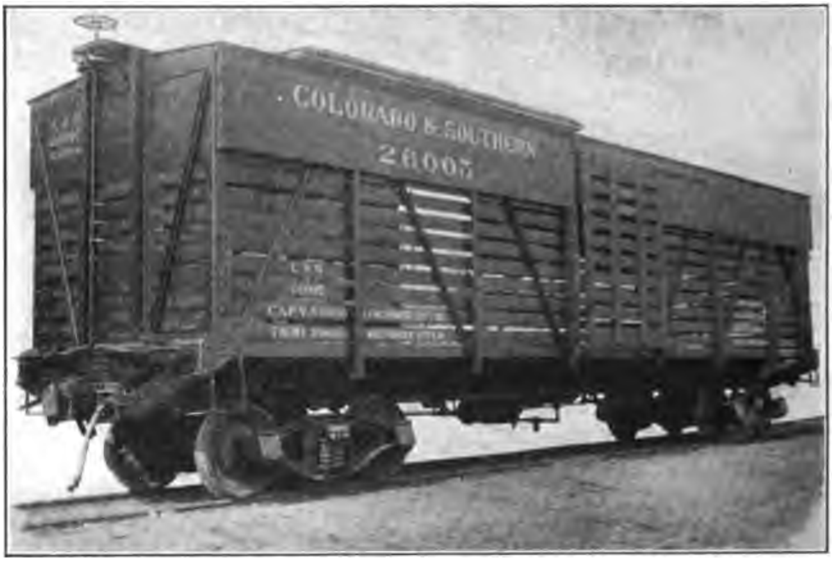


FIG. 62.—Side elevation, combination stock and coal car.

actual necessity for fast service. This is made more impressive after seeing a train load of live stock rushed from Chicago or Buffalo to tidewater at breakneck speed and then know it to remain in stock yards for a week or 10 days awaiting space in a steamer for export.

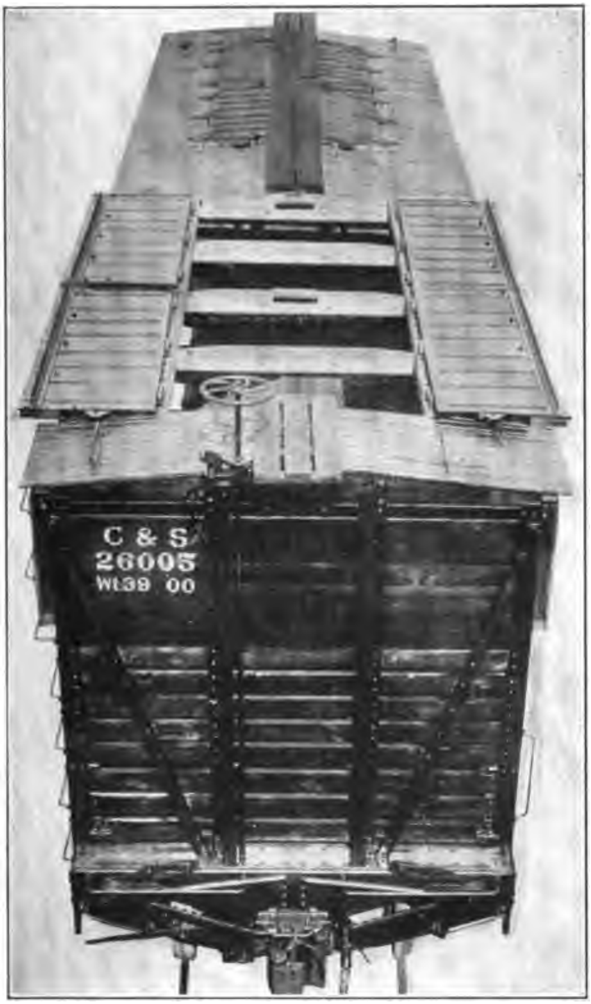


FIG. 63.—Perspective, combination stock and coal car.

Much can be done to protect live stock in transit and add to its comfort by intelligent loading and caring for it afterward. Horses need room and can balance themselves fairly well on a moving train or a boat. Preferably they should be handled in specially arranged cars with stalls, as is invariably done with race horses and frequently with horses of smaller value. Cattle are jolted backward and forward and travel more comfortably if packed reasonably close in cars and on boats, as they then support one another. It is nothing short of cruelty to put hogs in the same car with cows. This was formerly a common practice, but is seldom done nowadays. The hogs will bite and otherwise constantly annoy the cows.

CHAPTER XIV

WEIGHING FREIGHT

In theory every pound of freight transported should be accurately weighed, and this condition is being more nearly approached. The object is to insure getting the revenue to which the road is entitled and to protect the shipper against overcharge.

Carload freight is occasionally weighed by passing each team load to or from the car over wagon scales, but ordinarily by weighing the car with its load on the track scales most conveniently located for that purpose. The tare weight (that is the weight of the car itself, as stenciled on the side of the body) is subtracted from the gross weight to obtain the net weight. Many shippers insist on having cars weighed light as well as loaded, objecting to the use of the stenciled weight. For this service a small charge is made. Coal and a few other coarse commodities use the long ton—2240 lb.—which complicates the calculation. Many anthracite coal roads show the car weight in long tons and hundred weight, to aid the weigher in determining the net weight. The general practice is to have some definite rule whereby each loaded car is to be weighed on a certain scale in the direction of its movement, and the card bill on which car travels also indicates the point where the car shall be weighed. It is the usual practice to require car-load freight to be weighed at originating point if there are track scales. If none, then it is weighed at destination. If there are no scales at either the originating or the terminating point, the car is weighed on the first track scale passed en route. Light and bulky commodities, billed at a minimum weight under the tariff (where it is usually impossible to secure the weight by reason of limitations of car volume), are not usually weighed, neither is freight that is transported by measurement, estimated weight, rate per car, cord or thousand.

When shippers request weighing of loaded or empty cars for reasons of their own, there is usually no charge made where the cars move over private scales when being placed for delivery or when taken from sidings. Where an extra move has to be made, it is customary to collect at the rate of a dollar per car for general merchandise, if weighed on company scales; and 50 cents if on privately owned scales; and cars containing coal, on either company or private scales, 1 cent per ton. Occasionally the rules provide that for coal, if the scale weight varies to exceed 1000 lb. from weight shown on waybills, or stenciled weight, no charge is made for the discrepancy. On coarse freight, such as sand, clay or kaolin discharged from vessels to cars, the usual charge is 1 cent per gross ton for weighing on railroad scales. For general merchandise, the charge is generally 3 cents per ton. The rate for weighing empty cars is generally 50 cents, except on private scales where no additional switching is necessary.

Package freight, or l.c.l. freight, also commonly termed "house-freight," should be weighed at the point where it is received by the railroad from the shipper, in order to have the lowest freight charges entered on billing and to enable quick delivery to be made when it reaches final destination. An exception is sometimes made on freight that is handled in standard packages, such as flour in barrels, each weighing 196 lb., where a count of the barrels is sufficient.

The railroad is interested in track scales for weighing car-load shipments; house or platform scales for l.c.l. freight; team or wagon scales, usually for the accommodation of its customers; and special types of scales, such as large frame beam scales for weighing cotton, and permanently arranged scales for weighing coal or sand in pockets for supplying locomotive tenders.

Scales for weighing l.c.l. freight should be located along the side of the freight-house interior, where delivery is made from teams. They should be provided at frequent intervals—about 50 to 100 ft. apart—with the beams parallel with and adjacent to the side walls, to reduce chance of interference to trucking. They should be far enough away from the walls to permit storing freight against the walls.

Platform or freight-house scales —movable or stationary—are made in almost any size or style desired. The manufacturers make types suitable for special purposes. Some excellent multi-weighing scales were planned by the operating officers of the Merchants and Miners Transportation Company and installed in their Baltimore piers. With a number of beams and several weights on each beam, running up weights progressively, 16 articles may be placed on a scale and each weighed separately, without removing any of them. This is a great advantage at that and similar points because frequently a number of consignments will be taken from teams before a trucker gets around; and rehandling is thereby avoided.

Another company has something similar to the Merchants and Miners scales in a platform scale with a self-locking poise beam on which different commodities may be weighed and kept separate: for instance, cotton may be weighed on the upper bar, then sugar on the second bar, salt on the next and so on.

A type registering beam scale is furnished, with which the operator, at the end of each day, is enabled to have a certain number of checks showing number of loads that have passed over the scale. The recapitulation of these slips gives the total weight of the loads for the day. The slip is placed into the type-registering device and when the bar is secured it is clamped together and the weight is imprinted on the slip.

Team or wagon scales are ordinarily best located at the entrance to the team yard, where they will not obstruct the movement of teams going to or from the yards with no freight to be weighed. They should be located in that part of the yard where commodities which are ordinarily weighed on teams are generally handled.

Track scales for freight service range in capacity from 100 to 150 tons, with platform length of 36 to 60 ft. On longer scales cars may be weighed without stopping, as they move by gravity. The long scales (80 to 100 ft.) are not found reliable because of their great length, and are not being used except in extraordinary cases.

The location of track scales has been fully considered in other chapters. There is much variance of opinion among operating and constructing officers as to the proportionate number of cars to be weighed to cause scales to be located just beyond the hump of a classification yard rather than on the hump. Views expressed place the proportion anywhere from 5 to 25 per cent. of the total number passing through the yard. The Am. Ry. Engineering Ass'n assumes "that the greatest economy would be secured by locating the scale on the hump, if it is assured that from 5 to 10 per cent. of the cars must be weighed." Mr. North, Engineer of Construction of the Lake Shore and Michigan Southern says, "there is no possible scheme of grades for a hump where a scale is placed within the hump limit, which will enable traffic to be handled within 50 per cent. of the speed that can be secured at the same point, if the scale is not placed on the hump." The Association's Committee differed with Mr. North and cited instances where 300 cars an hour had been classified and weighed over a hump and scale, for a limited time. It was suggested that scales of higher capacity than ordinarily required be used, with correspondingly greater length of bearings. This would enable operation without the usual dead track; and by placing the scale very close to the hump's summit, the retardation due to scales would be greatly reduced. This can only be done to advantage where a large proportion of cars passing over hump have to be weighed, and it would be necessary to keep a stock of spare scale parts on hand to replace those with worn bearings as often as required. Cars not to be weighed, in running rapidly over scales, wear the knife edges; and when these become dull the friction is increased, requiring more weight to overcome the inertia of the parts. The accuracy of scale weights depends largely upon the sharpness of the bearings.

The Pennsylvania standard track scale is 52 ft. long and of 300,000 lb. capacity. Some of the original and unique features are suspension bearings supporting the platform, mechanical relieving gear which eliminates the dead-rail, and a mechanical hump which provides the proper control of the movement of cars over the scale.

The Baltimore & Ohio standard track scale (shown in Figs. 64, 65, 66, 67, 68 and 69) is 50 ft. long, of 300,000 lb. capacity, "pit-suspension-bearing," and consists of four sections.

The bridge is made up of two 24-in. 80-lb. I-beams under each scale rail to provide rigidity and to better distribute load over the bearings. The ties crossing I-beams provide a cushion and protection to the scale and serve to brace it. The grade on hump scales is made with them and adjusted to 0.75 per cent. grade.

The scale parts are 54 ft. long while the scale rails are but 50 ft., causing the load to be applied to the scale inside of the first bearing, distributing a part of the load to the second bearing and preventing a reflex action of the bridge.

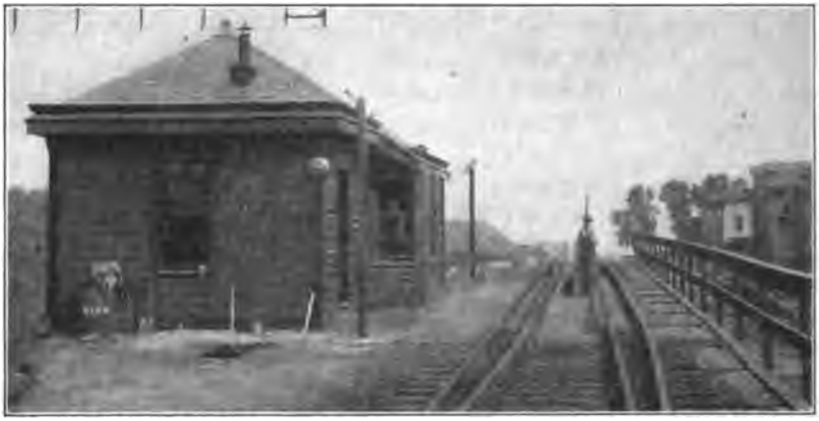


Fig. 64.—Standard track scale—Baltimore & Ohio.

To further relieve impact on the scale, a buffer or transfer rail, made of maganese steel, is used to transfer the load from the approach to the scale rail. This is bolted to the approach rail and the box beams, and carries the outside tread of the car wheel. The buffer is in no way connected with the scale. Ample clearance is provided by cutting it out underneath and planing off the outside head of the scale rail. All levers and other parts are designed to carry a load of 75,000 lb. per section—allowing for dead-weight, and 100 per cent. for impact. The main and the fifth levers, the cross-bars and the rocker are made of cast steel; other levers of cast iron. Locomotives may pass over scales of such capacity without damaging them. When a lever is deflected, its two arms are liable to have different relative positions under different loads, and this interferes with its proper adjustment, making the scale inaccurate; it is, therefore, aimed to keep the deflections of the levers at a minimum. The stands are rigidly supported by concrete foundations, and the load is supported at eight points on the middle pivots—commonly called the knife edges—of the main levers. From these the load is transmitted and reduced through the extension,

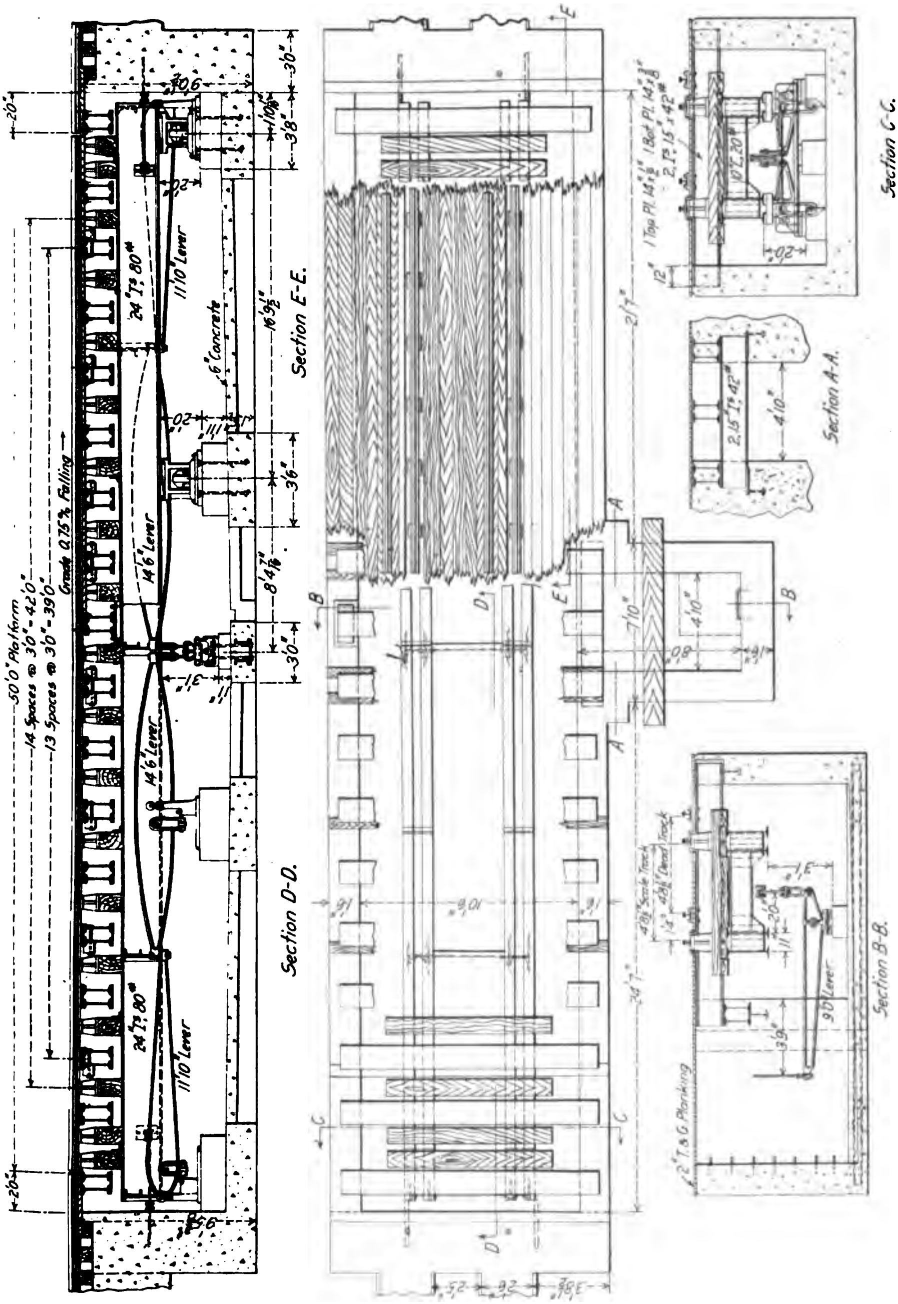


FIG. 65.—General arrangement, track scale—Baltimore & Ohio.

fifth and shelf levers, to the beam, at which point a force of 1 lb. balances a weight of 800 lb. on the scale.

The construction of the suspension bearing is shown in detail (Fig. 68) and, as shown in the section *C C* of the general arrangement of the scale (Fig. 65), the load is transmitted from the rail through the scale stands, the ties, I-beams, or bridge, to the bearing yoke and then to the cross-bar and rocker. The rocker is suspended by two 1.5-in. links hung from a bearing block, which rests in the knife edge of the main lever. The arc of suspension from the base of the rail to the bottom of the rocker is 79 in., which gives the platform a freedom of action with sliding friction, longitudinally, between links, rockers and bearing blocks and a transverse pendulum motion in the main lever pivot. The rocker compensates for any deflection there may be in the bridge, and a uniform bearing on the knife edge is always secured. The wedges, as shown on the top of the bearing yoke, provide the means of securing a uniform distribution of the load on each section, which might otherwise be prevented through the unevenness of the I-beam, the installation or the wear of the scale parts. The extension lever parts are provided with compensating steels. The accessibility of the nose iron pivots, and the means provided for proper alinement of these levers is notable; and leveling tabs are fitted on the top of levers. All pivots are accessible for inspection and cleaning. The pit is 54 ft. long, 10 ft. 6 in. wide, 7 ft. 3 in. deep, and equipped with electric lights. On the theory that more scales rust out than wear out, the inaccuracy and short life of many of them may be traced to lack of attention in the way of cleaning, inspection and testing.

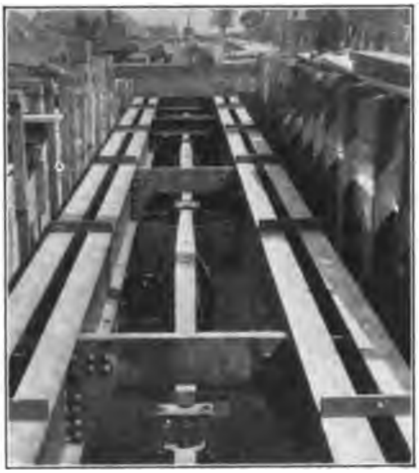


FIG. 66.—I-beams for bridge, track scale—Baltimore & Ohio.

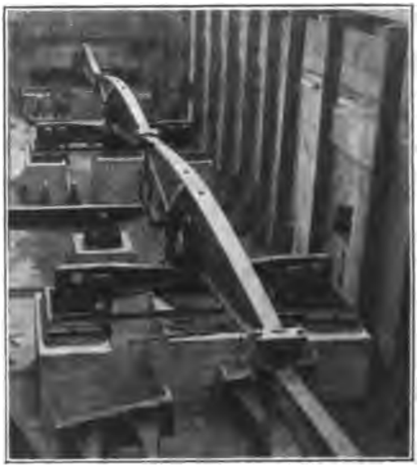


FIG. 67.—Lever arrangement, track scale—Baltimore & Ohio.

The main lever stands rest on 2-in. bed plate castings, which are anchored to a concrete pier through slotted holes. The slotted holes in the stands are at right angles, permitting some adjustment lengthwise or crosswise, which

may be found necessary. No loops or links are permitted to vary more than 1/16 in.

To handle freight properly, as to weight, charges and loading, correct weights should be used as stated in the foregoing. The methods of obtaining weights are:

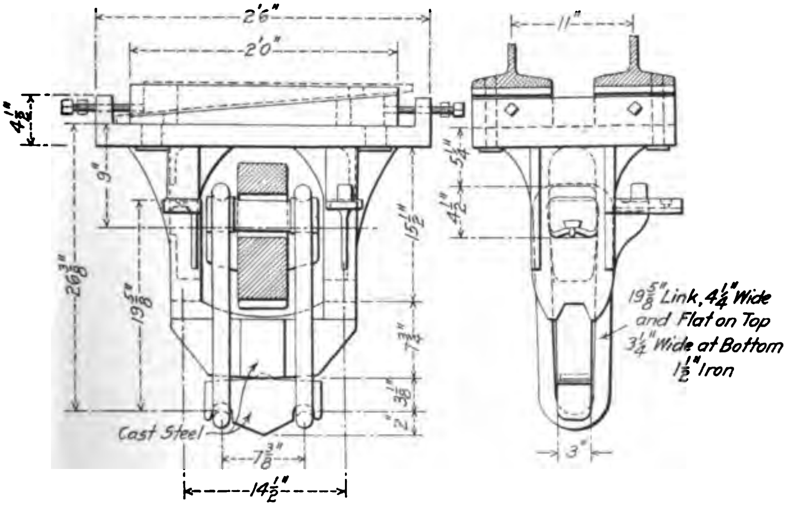


Fig. 68.—Detail of suspension bearing, track scale—Baltimore & Ohio.

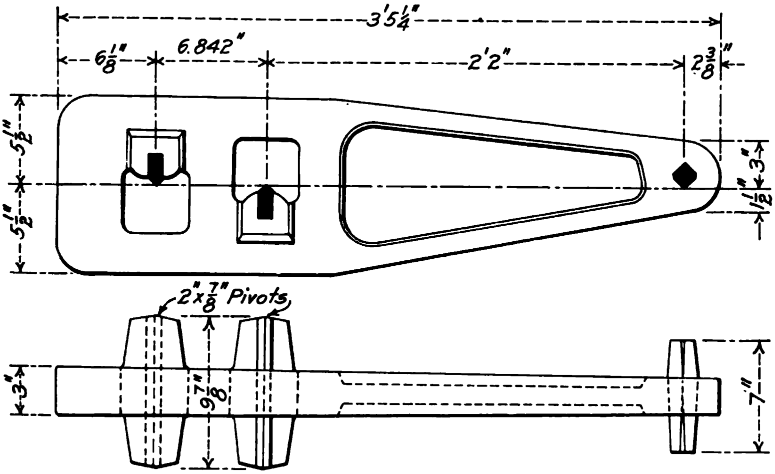


Fig. 69.—Detail of transverse lever, track scale—Baltimore & Ohio.

1. Weighing at initial point.
2. Accepting shipper's weight under proper weight agreements.
3. Standard weights.
4. Estimated weights.
5. Connecting line weights.

The weighing of l.c.l. freight was facilitated in a large outbound freight-house by adjusting all hand trucks, by adding leaden weights to them, thereby bringing them up to a predetermined uniform weight. The platform scales were then adjusted to balance, with the empty truck on the scale. A support was also placed on the scale and included in the adjustment to enable the truckers to rest the handles of the truck at the normal trucking height, avoiding the necessity of stooping down to deposit the loaded truck on the scale, and again to move it, thereby saving much time. This is one of the practical applications of "scientific management."

The rate of speed for weighing has been investigated recently. It was found that the right speed for accurate weighing is somewhere between 3 and 6 miles per hour, according to the skill of the weighman. At 4 miles per hour over a 46-ft. scale, the rate is equal to about six cars per minute and at 5 miles per hour, to about eight cars per minute. As many as 10 per minute have been weighed by a skilled weighman.

The accuracy of weighing, when cars are not uncoupled, has often been questioned. The Association of Accounting Officers, June 27, 1906, decided that "Based on practical experience, proper care being exercised, correct weights can be determined on track scales by weighing cars coupled at both ends, coupled at one end, or uncoupled at both ends."

Variations in tare weights of cars was gone into in a hearing before the Interstate Commerce Commission in Chicago, March, 1912. Testimony was introduced tending to show that during January, 1911, out of 384 cars weighed by one industrial concern, on 132 a variation of 500 lb. each from stenciled weights was found; 97 of them weighed 141,350 lb. over stenciled weights and 35 weighed 37,690 lb. under. During June, 1911, of 317 cars, 95 showed variations of 500 lb. or over, 21 of them weighed 47,300 lb. over and 74 weighed 83,420 lb. under stenciled weights. It was explained that the variations were probably due to the effect of snow and ice in the cars in January, and that débris and other foreign substances frequently affected car weights. Of the cars weighed during 1911 by the weighmasters of the Western Ry., Weighing Assn. and Inspection Bureau, 73 per cent. had a stenciled tare exceeding the actual weight. On the Santa Fe it is the practice to weigh all cars other than those containing live stock uncoupled while not in motion.

Coal weight shrinkage was discussed by the International Railway Fuel Association in Chicago, June, 1909, in connection with the subject of correct weighing of coal at mines and on railway track scales, including legitimate shrinkage allowable on car lots. The false impression prevailing regarding the effect of weather on the weight of loaded coal cars was referred to. It was asserted that a full inch of rain, falling on and retained by the coal loaded in a 36-ft. car would increase the weight 1600 lb.: but as drainage occurs almost as fast as the rain falls and as evaporation is rapid, the effect is only temporary. In the discussion of this report the secretary submitted an interesting statement of a test made by the St. Louis and San Francisco, of coal from the Pittsburg, Kan., fields, to determine the shrinkage or gain due to weather conditions. The test was made in the latter part of May and extended over 13 days. There were 25 cars, 10 box or stock, and the remainder open cars. The average moisture content of coal from this district is 2.85 per cent. During the first 7 days there were light rains on three different days; but with one exception the loads showed a shrinkage in weight averaging 0.24 per cent. for the closed cars and 0.64 per cent. for the open cars. Following the seventh weighing a heavy rain set in which continued through the following day and until 4 a. m. of the second day, the weather clearing at noon and continuing clear throughout the rest of the test. Weights on these days were taken at 1:30 p. m. Although weighings of the closed cars were discontinued after the tenth day, the weight showed an average shrinkage of 0.05 per cent. The open cars showed a net gain in weight of 22,360 lb. in the first weighing after the heavy rains, which shrunk to 4150 by the end of the test, an average of 188 lb. or 0.14 per cent. per car; and while the extreme gain and shrinkage for individual open cars were 1080 and 450 lb. respectively, the average result well bears out the committee's statement that the weather effect, on the whole, is relatively unimportant.

Correct stenciled weights on cars are essential. Every car should be light-weighed and re-marked at least twice a year. Errors in stenciled car weight may occur through:

Shrinkage of material in wooden cars.
Absorption of weight in wooden cars.
Repairs or re-timbering of cars.
Exchange of trucks or other parts.
Errors by weighers or re-stenciling employees.

Among the causes which lead to incorrect weights of contents, the following may be mentioned:

Defective scales.
Improper maintenance and inspection of scales.
Faulty or inefficient weighing.
Incorrect stenciled car weights.
Improper inspection and preparation of cars to prevent leakage.

The Master Car Builder's rules provide for the re-weighing and re-stenciling of wooden and steel underframe cars when one year old, the weight figures to be followed by a star; when two years, they are again re-weighed and re-stenciled and two stars added and when three or four years old the operation is again repeated, adding three stars indicating the weight to be final.

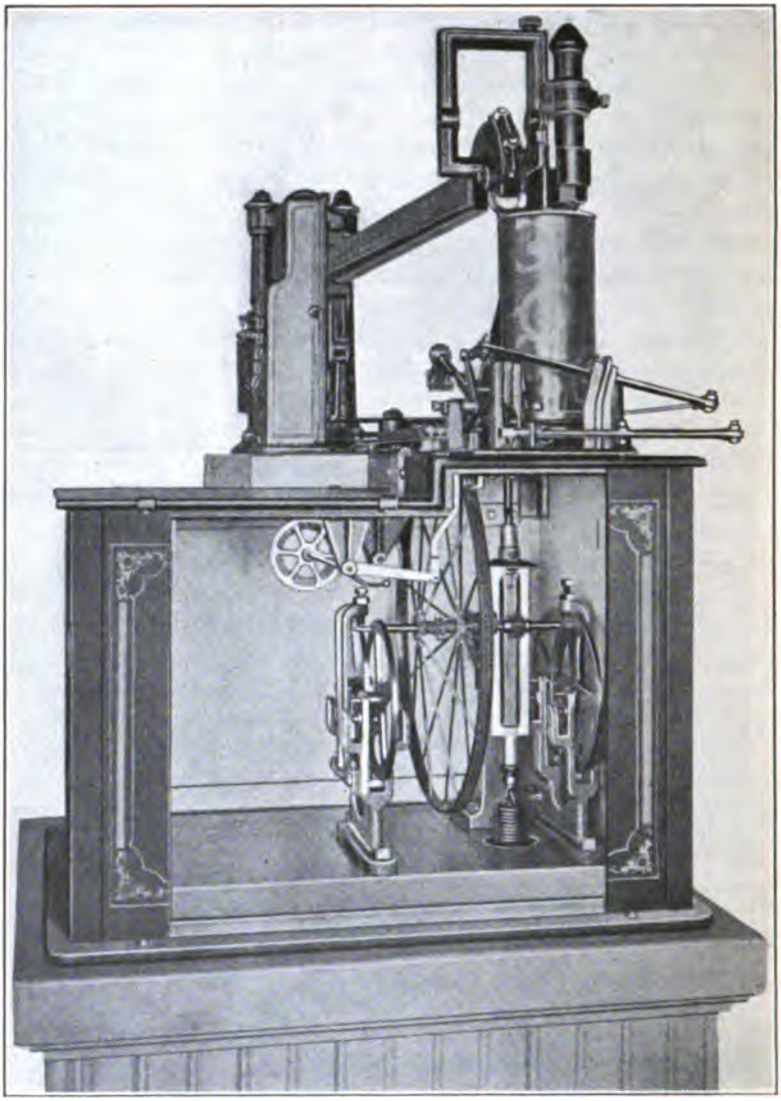
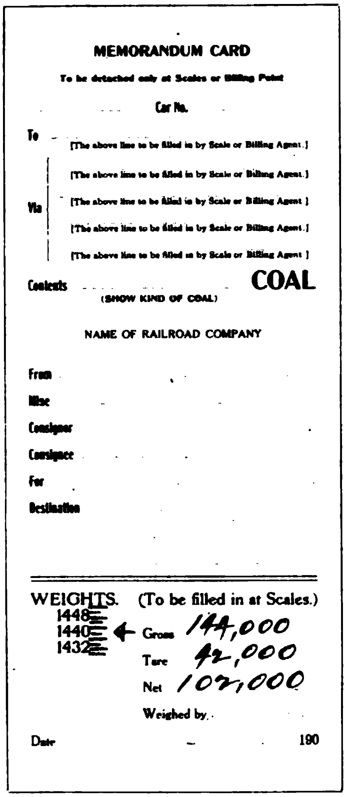


FIG. 70.—Automatic weight recorder.

Disputed railway scale weights on the testimony of wagon scales on which the car contents are weighed are not infrequent. Railway officers should not accept this evidence unless satisfied that it is accurate. The consignee may be misled by errors in weighing, defective scales or confusion in his own weights. Wagon scales are seldom kept in proper condition; they are almost invariably exposed to the weather, and depreciation is rapid. Very few are equipped with type registering beams and



MEMORANDUM CARD

To be detached only at Scales or Billing Point

Car No.

To

[The above line to be filled in by Scale or Billing Agent.]

Via

[The above line to be filled in by Scale or Billing Agent.]

[The above line to be filled in by Scale or Billing Agent.]

[The above line to be filled in by Scale or Billing Agent.]

[The above line to be filled in by Scale or Billing Agent.]

Contents COAL

(SHOW KIND OF COAL)

NAME OF RAILROAD COMPANY

From

Mdse

Consignor

Consignee

For

Destination

WEIGHTS. (To be filled in at Scales.)

1448

1440 ← Gross 144,000

1432

Tare 42,000

Net 102,000

Weighed by

Date 190

Fig. 71.—Scale card, for automatic weight recorder.

to add to the likelihood of error or confusion, many coal, grain and dealers in coarse freight, shape their loads and weighing to correspond with the orders on hand, adding to or reducing the weight of each load, as taken from the car, while the wagon is on the scale, thus making a continuous haul from the car to the customer. Instances are on record where an occasional wagon load has inadvertently reached the customer without being sent to the wagon scale. Now and then coal is first unloaded from car to bin and is thence taken to the wagon scale. The consignee frequently occupies from 2 to 4 days in unloading a car;

no protection being provided by him for the property during the night. The tare weight of the wagon is usually a doubtful factor; also the location of the driver, whether on or off the wagon when weighed light or loaded.

A western road is planning the installment of a device by which the weighmaster can revise the tare weights while the cars are on the scale, without appreciably slowing up switching.

An automatic weight recorder is shown in Fig. 70. This device may be attached to any track scale. It records the weight of cars moving over scales, either coupled in the train or by gravity.

Besides printing a permanent and accurate record of weights it enables cars to be passed over scales much faster than by the ordinary method. Figs. 71 and 72 show a scale card and the recorder tape used in the machines. These records are valuable in contesting claims.

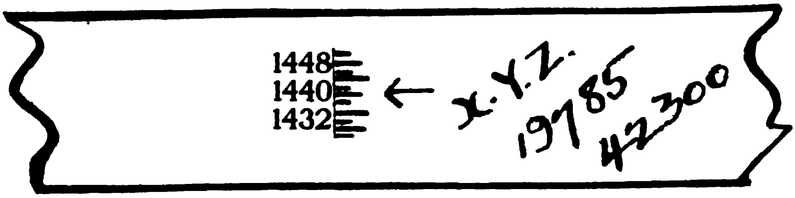


FIG. 72.—Recorder tape, automatic weight recorder.

An automatic electric coal-weighing machine has been perfected for weighing coal. The coal runs into a hopper by means of a vibrator connected directly to a motor by a shaft. When the hopper contains enough coal to counter-balance the weights, a lever connected to the weight beam trips a switch, stops the motor and vibrator, and, by magnet, releases the discharge gate, allowing the coal to run out. As the hopper, relieved of its load, rises, the weight arm again actuates a controlling device, which closes the discharging gate, starts the motor and the operation is repeated. A register on the hopper records the number of times the hopper operates.

CHAPTER XV

RECORDS AND STATISTICS

For yard and terminal work and road handling in its relation to the terminals it is necessary to keep certain records to enable the supervising officers to know that cars are properly moved, placed or delivered and to direct such work, and it is necessary also to arrange certain statistics with these records as a basis, whereby those in charge of and responsible for operations may know that the work is being handled in a satisfactory manner as to time of movement (service) and expense of work performed (cost).

Records vary on different roads, and in the different terminals of the same road to meet the different and varying conditions. It is customary to have a record of the cars contained in each train arriving at the terminal; occasionally this is telegraphed to the yardmaster in advance, sometimes it is made up by the conductor and handed to a yard clerk on arrival and again it may be made up after the train has arrived. The card bills are delivered and checked with this list, and usually the train is marked up for switching or is switched by it. The list should show the car numbers with the names or initials of owning roads; whether empty or loaded; kind of car; kind and condition of seals on each side door and on end doors, if any; contents and final destination. The heading should give the number of the train and engine, direction of movement, total number of loads, empties and gross tons, also the names of engineman and conductor. The cars are entered up from this list into a car-record book from which all cars are checked and traced. This is a very important record and will be described in detail later. Records of transfer or inter-yard movements; cars to and from shops and repair yards and other points are similarly reported by the conductors of the yard transfer or road engines moving them. Each yard keeps a record of its handling of cars made up in a more or less complicated manner, depending on the extent of the yard and the number of movements required.

In all yard handling the line of demarcation between service and cost must be fixed, and the general policy very largely determined therefrom. It is not exactly a case of "all the traffic will bear"— but to a great extent, the commercial yard and freight-house work is operated at the lowest cost permissible and for which the shippers will stand, commensurate with the demand for cars in revenue service. When cars are a drug on the market, their quick release and prompt handling are of less importance than when a car famine exists. Records and statistics are helpful in watching the line.

The record and report business, essential as it is, may be more easily overdone and rendered an actual obstruction, rather than an aid to real result, producing work than any other kind of work on a railroad system, for the reason that any general office clerk usually has or assumes the authority of calling for reports while it is often nobody's business to discontinue or reduce. The evil is naturally greater on railroads operating under the departmental system.

An unfortunate condition exists in the transportation department of some railroads on which the operating head has not the time necessary to watch such details as yard or train reports and is dependent largely, if not wholly, on a chief clerk or other subordinate officer. The chief clerk is, what is termed in railroad parlance, an "office man"; that is to say, one who has gained his railroad knowledge in an office and has, therefore, had little practical or actual outside experience. As a natural result, when he wants anything he asks "somebody" for it. Had he in times past worked as or with a switchman, a yard-conductor or a yardmaster, he probably would know that the information desired was already being received in some form. It may be, too, that the chief clerk is a "six o'clock man."

The writer knows of instances where reports requiring many hours' work, were sent in daily by yardmasters, trainmasters and superintendents, which had not been needed or used in years. When the discovery was accidently made, the explanation followed that there had been a time once when the information was required.

A system of reports or blanks is usually prepared by a clerk who is expert in that kind of work. He makes an estimate as to how long it will take him to make out each report. He may not take into consideration the fact that what he with his special training can accomplish in 8 or 10 minutes in his office at a desk with ample light, ventilation and heat, may take a yardmaster or other outside employee, not so skillful with a pen, five or ten times as long.

In one office, the writer was shown an elaborate report of engine movements at terminals. It required records to be kept by eight different persons, and these were consolidated on one blank before being sent in. It was a fine production. A superintendent could easily put in 2 or 3 hours daily in getting unnecessary lessons from it. Many reports are made and pigeon-holed because they may be needed "some day.' Somebody is paying for them in the meantime.

In a large terminal, a yard engine was assigned to a district and its work was usually behind. The work done was analyzed and it did not seem sufficient to justify the use of more than one engine. The conductor spent about 2 hours a day working on "reports" and while he was an exceptionally good yard-conductor, he had neither the ability to plan work successfully for others, or to take a prize as a rapid recorder and report-maker. Moreover, the greater part of his reporting was of cars moving from one point in his district to another, the car service office having at some time in the past asked for this information. There being apparently no use made of this information, he was told to discontinue sending in this report. There were no further complaints of work not being done in that district, and years passed without anyone in the car service office discovering the discontinuance of the "interior" car movement report.

The writer has frequently watched a freight conductor making out his switch-list while riding in the cupola of a four-wheel caboose, rounding the curves, and bracing for the running in and out of the slack in the 80 or 90 cars ahead. With 50 or 60 of the cars air braked, this feat requires agility. A lantern, tucked under the conductor's arm, gave all the light to be had and further embarrassed him in endeavoring to comply with the printed instructions, "write figures legibly." To put down 80 numbers of five figures each, about 400 in all, under such conditions, in a space so small that they could hardly be inserted by one of the "Lord's Prayer on a dime" experts, and adding the initials of the cars, the designation for "loaded" or "empty," giving the contents, kind of car, originating point, road's destination, final destination and in many cases, the record of seals on each side of each car and on end door, must of necessity take up much of the conductor's time. Clerks should do as much of this kind of work as possible. These road and yardmen are not chosen for their book-keeping ability. Committees of road employees have been known to defend negligence in the physical handling of their trains, by claiming that the individual conductor or trainman was engaged in "making out his reports."

To operate a terminal satisfactorily it is essential that records of all movements be kept. These reports and records are not altogether for the purpose of answering questions asked by those at a distance relative to movement or location of certain cars. They are primarily to enable the yardmaster or other operating officer in charge of the terminal to inform himself at any time as to the general situation. It is apparent on many roads that the report and record business — especially the report—is overdone. This seems to be due to an increasing demand for information and the closer tracing of freight by shippers and traffic officers. The easy abuse follows, by which department heads and officers ask for more and more reports by wire, or mail, or both, weekly, daily and oftimes at several specified times daily. The result is to demoralize and confuse the organization and overload the local forces with a mass of detail apparently serving no good end. It prevents the local operating head from receiving the information he needs in the conduct of his business. As he cannot secure a considerable increase in clerical and other forces, without being able to show a corresponding increase in traffic to justify it, the business of the terminal suffers. All the information asked for in the special and additional reports is usually already made up and sent in, in some form or other, but is perhaps not readily and conveniently abstracted, or is not known to be at hand by the clerk in charge. In any event it seems easier to wire the superintendent or yardmaster for it. When such additional demands for information are made, a general revision of the entire system of reports, cutting out five or six that are going in and substituting one or two simplified forms, will in many cases accomplish the desired result and enable a reduction of clerical work at the terminal, instead of necessitating an increased force. It will also enable the superintendent to get more result-producing work out of his subordinates. When that ideal condition is reached in a terminal where no questions need be asked, special reports will not be needed.

One of the first essentials and doubtless the most important, is to keep records by which one can intelligently and with reasonable accuracy determine the cost of handling a terminal, adopting some unit as a basis, for comparison with other terminals and for comparison with itself during a previous period. That both comparisons are beset with difficulties is apparent. Many factors enter into the computation and allowances have to be made for weather conditions, changes in character and volume of traffic, increased or decreased number of cars or tons for private sidings or warehouses (where work is attended with extraordinary difficulties) change in power used, kind of fuel, amount of passenger work, revision of loading and transfers, regulations imposed by the Interstate Commerce Commission, State Boards of Railroad Commissioners, Public Utilities Commissions, Boards of Trade and similar bodies.

In an able address before the New England Railroad Club, Mr. W. J. Cunningham, Assistant Professor of Transportation in the Graduate Business School of Harvard University explained that to be of full value, statistics should have certain requisites, viz.:

The basic information carefully compiled and averages or units accurately worked out.

They should be fresh and vital; postmortem analysis being ineffective; the figures should be available promptly, so that when need of a remedy is indicated it may be applied at once.

They should be comprehensible, easily understood and the vital features shown clearly; they should be neither complicated nor involved.

They should be comparative whenever possible; that is, comparable with other periods, other divisions, or other railroads, and with other related figures.

Mr. Cunningham sounds a much needed note of warning:

> "I desire to emphasize that no matter how valuable statistics may be, they cannot be taken invariably as conclusive or absolute in their indication. They should be used only as *aids to judgment*, and in that capacity are indispensable to economic and efficient management. Statistics are of little value unless used; they are but a means to an end and their function is unperformed unless the information and indications which they convey are noted and acted upon by those in authority *and an interest taken by the men who do the work*. In other words, the figures in themselves cannot perform miracles, but they have a high potential value when their suggestions fall upon the receptive, resourceful and active mind of the man responsible for results."

Endeavors to compare one division with another or one yard with another, are ordinarily of little value. Weather conditions, water, grades and fuel, have each a share in producing differences in cost which it is difficult to estimate, but apart from this, there is an even more serious difficulty in making comparisons between two or more railroads. The data used in compiling results are rarely available, and when available are still more rarely harmonious. By comparing one division or district with itself for a corresponding period, the difficulties of water and grades are largely eliminated or at all events any change is on record; and fairly reliable conclusions may be drawn from such comparisons. Most roads divide their statistics as between east- and westbound or north- and southbound. Such division may be useful as denoting the general trend of traffic, but it seems more than probable that a further subdivision setting forth such traffic as is in the direction of the balance of traffic, as distinct from that in the direction of turning power, would be a truer basis from which to criticise locomotive or train performance. With the present system, assuming the balance of tonnage for an entire month is eastbound, it is possible that during a large portion of the month the balance was in the opposite direction and, as a consequence, eastbound results as shown are misleading and the good actually attained by careful loading, proper handling of empty cars and economical fuel performance, is lost sight of.

The unit of cars handled is probably the only practical one. In this, however, the figures may be manipulated so that they are misleading. Every movement of a car may be counted, in one case, and only arrival at and departure from terminal in another. In the former it may count as ten, or even more, and in the latter as two. What constitutes a car movement, or a car handled must first be determined.

For the reasons outlined, the basis of computation, cars handled, is about as unsatisfactory for the purpose intended as it is possible to make it. It is, nevertheless, the one used more often than any other. The yardmaster's desire to make a good showing for himself and his yard by reducing the cost per car handled will induce him to run up the number of cars handled to the highest figure.

The writer at one time had charge of a large marine terminal yard, and had reduced the cost of handling to what he considered a fair figure, and included every car movement that he conscientiously considered right and fair, in the number of cars handled. An interior yard of very much smaller size and lighter business showed a decidedly lower cost, to the surprise of every one. Inquiry developed that the smaller yard showed a much greater number of cars handled than did the larger yard. Knowing that this was not the actual condition, the writer spent several days in the interior yard and analyzed its methods. The business actually done did not compare with that of the marine terminal, but every movement or apology for a movement was recorded and reported. A record was kept of a car moving from the general yard to the transfer platform; from the transfer to the freight-house; from freight-house back to transfer and again back to outgoing yard. Aside from the manifest unfairness of the method, the amount of time spent on these reports should be considered. This was done by men not trained nor intended for that kind of work, and all of it was absolutely useless. This instance in practice will illustrate the futility of using the present general methods of accounting in yard work, for the purpose of making comparisons between yards, unless an understanding is first arrived at as to a common and uniform basis.

An excellent plan has been advanced—and it was many years ahead of the times when actually tried—in the determination of units in yard work and basing thereon a standard for comparison, every item of work and cost being analyzed and separated. It was then commonly known as the "standard unit" method. The actual performance for a period of months or years back was taken and from it a statement was made dividing up all the principal items of work done, and the cost. This basis was used as the standard with which comparisons of following months were made and increases or decreases explained. Some of the items to be enumerated are:

1. Cars received and forwarded in trains.
2. Cars delivered to and received from connecting lines.
3. Cars delivered to and received from private industries.
4. Cars to and from freight-house and team tracks.
5. Cars to and from coal chute tracks.
6. Cars to and from transfer tracks.
7. Cars weighed.

The total of these items would represent the number of "cars handled" and it is necessarily many times greater than the actual number of cars involved in the computation.

For illustration, let it be assumed that there were handled, the first month, a total of 7000 cars and the same number the second month; with the exception that the second month there were fewer cars handled in certain movements and more in others. Using the item numbers in the list of movements just given:

Items	First month	Second month
1	1,000	500
2	1,000	500
3	1,000	1,000
4	1,000	1,000
5	1,000	1,000
6	1,000	1,500
7	1,000	1,500
Total,	7,000	7,000

To apply the "standard unit" method, it is first necessary to fix a value for each item. A movement may become more difficult and expensive. An industry may change its track connections or may change the method of loading or routing of cars requiring less "spotting" of such cars when being placed. The movement may be made less difficult and expensive. Approaches to a coal chute may have a reduced grade or improved track connections enabling a locomotive to put up more cars than formerly. It is therefore desirable from time to time to revise the standard.

Assuming item No. 1 to be the simplest, the value may be placed at 1. Item No. 2 may be no more difficult than item No. 1 and would be given the same value. Items Nos. 3, 4 and 5 each require three times the work of item No. 1 and would be placed at 3. Items Nos. 6 and 7 may each require twice the work of item No. 1, and their values would be placed at 2. Taking the case where 1000 movements were made in the first month under each head gives the following number of units:

Items	Cars handled	Value of each	Total units
1	1,000	1	1,000
2	1,000	1	1,000
3	1,000	3	3,000
4	1,000	3	3,000
5	1,000	3	3,000
6	1,000	2	2,000
7	1,000	2	2,000
Total,	7,000		15,000

Dividing the 15,000 units into the total cost of handling the terminal for the month, gives the cost per unit for purposes of comparison.

Applying the unit basis to the month following in which the total number of cars handled was the same but varies as between the items:

Items	Cars handled	Standard values	Total units
1	500	1	500
2	500	1	500
3	1,000	3	3,000
4	1,000	3	3,000
5	1,000	3	3,000
6	1,500	2	3,000
7	1,500	2	3,000
Totals,	7,000		16,000

While the number of cars handled is the same in each month there were 1000 more units of work performed and with an increased total cost of handling of 6.7 per cent., the cost per unit would be the same. If the standard of values has been correctly assessed this would approximate actual conditions. The writer used this system very successfully and satisfactorily in a large and busy terminal.

In some terminals the whole computation has been made on the basis of number of cars received and forwarded in trains and cars delivered to and received from connecting lines. This is not worth while. In other terminals the calculations of cost are based on the number of cars in and out in trains, and cars switched for revenue. Aside from the futility of so comparing the yard work done on one road with another, there is probably little use in endeavoring to bring about a satisfactory comparison between any two yards on the same road. There is no good reason why the "standard unit" system cannot be satisfactorily used for several or all yards, and the general officers of the transportation department could have figures showing the operating cost of the different yards that would mean something.

Under the system of assessing values to units of yard work in each yard, it is necessary, if comparisons between two or more terminals are to be made, that the value of the units be established on some uniform basis. To secure uniformity of values a committee might be appointed to fix the value of each unit in the different terminals. It would be well to have a representative from each important terminal on this committee and three or more general transportation officers to act as arbitrators. After the values are once fixed they need not be disturbed until some change in conditions necessitated a local adjustment.

This method is not intended to apply to the figures given and records kept of the cost of classifying cars in terminals by summit, poling, or gravity methods, because there are no great complications in the kinds and costs of train movements in such yards, and so the figures usually kept of such operations are full of meaning and of the greatest value.

The contract, or so-called "piece-work" system, would seem a most satisfactory one to use in classifying yards worked by either summit, stake or gravity methods and its use here, as well as in freight-houses, would tend to greatly simplify the record problem. It is not difficult to estimate the cost per car, and the men under their foreman, as a subcontractor, could be paid on that basis at the end of the month or week. This would tend to do away with the necessity for supervision and paying overtime, and would under the law of the "survival of the fittest" weed out the sloth and drone. Damage to cars might be expected to be reduced, because a derailment or accident obstructing the work would cause the men to be idle and lose pay.

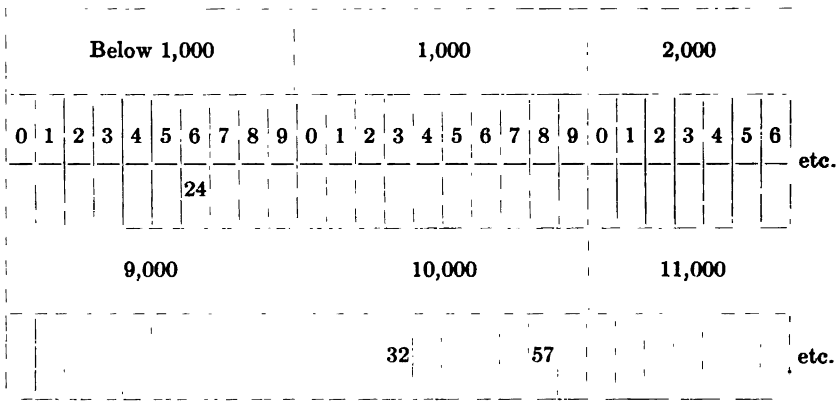
A simple, intelligent, accurate, reliable, and closely followed up car record is essential in any yard of even moderate proportions. The usual error made in adopting a record in yards that have been operated without any records is to record more than is absolutely essential. The record should give just such information as is needed in the particular terminal in which it is installed, and no more. The per diem method of paying for the use of cars has made records necessary where they were not needed before and has extended those already in use. The movement of cars in and out, on each of the various divisions and connecting lines involved, whether loaded or empty, cars to and from shops, freight-houses, etc., are necessary in a car record at the average division terminal.

One of the simplest and most economical records is that using the ending or terminal figure of the car, and where nothing more is required, it is decidedly the best. This is usually kept on large loose sheets divided into 10 squares each, the last figures across the sheet and the second and third figures up and down making it necessary to write only the figures in advance of the three last ones in each number. As men become accustomed to it they can fill in the numbers very rapidly. One man should easily enter up 2500 car numbers a day besides replying to telegraphic and telephonic inquiries as to cars. The date is entered, abbreviations for divisions, connections, etc., by using A, B, C, etc., and the symbols X for loaded and — for empty. The X or — is placed ahead of the number when it indicates "arrival"; and after the number when it indicates "departure."

A simple form of report is one on which each sheet is divided into 10 squares, numbered 0, 1, etc., to 9, inclusive. The car numbers are entered in full, and all those ending in the figure 1 in the space headed 1, etc.; in this record it is only necessary to look up one-tenth of the entire lot of numbers when one is wanted.

The following represents a part of the so-called "terminal number record":

Numbers of........................Cars........................



There are 10 squares across the sheet and 10 vertically, the heading of the last square, the lower right-hand corner, reading 89,000. In practice, a sheet is usually used for the movements in each direction daily, although it is customary in some yards to use a sheet for each period of 8 hours, thereby getting a close approximation to the time of day. In the figures above cars 624, 10,332 and 10,857 are entered.

Another simple form of record, useful only in small terminals, is that of having each conductor, on arrival, bring in a list of cars and having a yard clerk note the departure opposite the numbers of the cars as they move out. These lists are deposited in a pigeonhole in a large case having a compartment for every day in the month.

An elaborate record is sometimes kept in which no part of the car number itself needs to be written. A book of 100 double pages with 10 horizontal divisions across the page and 100 lines vertically is used. Car 18,945, for instance is entered on page 45 in horizontal division 9 and on line 18. The owning road's initials or its customary abbreviations are entered with the indications for load, empty, date (occasionally time) of arrival or departure, etc.

The use of a certain colored ink for cars arriving between midnight and 8 a. m.; another for those between 8 a. m. and 4 p. m. and another between 4 p. m. and midnight is followed at some points, to give a pretty close line on the time of arrival. One of the objections to this form of record is the large amount of leafing of the books, making it difficult to bind them substantially enough to last through their ordinary period of service.

One of the best car record books for a terminal is made up on the plan shown in Fig. 73. This record may be handled with three columns, instead of four, to each division, but it may be desirable to show time or

Page 01. Record of Cars at...190........

0			1			2			3			4		
Car	Rec	Fwd	Car	Rec	Fwd	Car	Rec	Fwd	Car	Rec	Fwd	Car	Rec	Fwd
L & N 37	X A 9/1		LEW 27	X A 9/1	B X 9/1				G T 2	X B 9/1	C X 9/2	So 85	–C 9/4	E– 9/5
5			6			7			8			9		
						I C 27	X F 9/4	A X 9/4						

FIG. 73.—Sample page of car record book.

other information, such as further movements, in which case the additional column may be needed. In the sample record shown the page is numbered "01." The pages run from "00" to "99" or upward. When they stop at 99 the book provides for any number to and including 99,999. The cars entered on the sample page given are 37,001, 27,101, 2,301, 85,401, and 27,701.

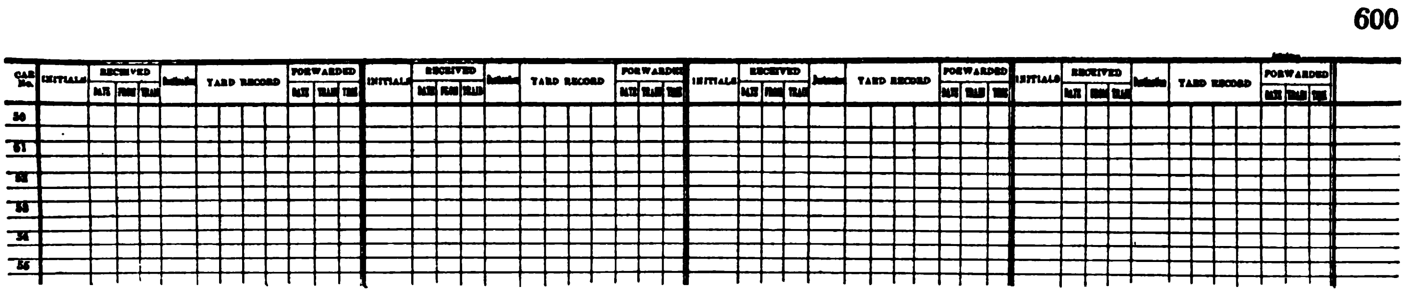
To more fully explain the working of this record the cipher used is as follows:

X	Loaded car.
—	Empty car.
A	Baltimore Division.
B	Omaha Division.
C	Boston Branch.
D	K. & A. connecting road.
E	Freight transfer platform.
F	Shops.

When the symbol X or — is placed before the cipher letter it indicates that the car was received; when it is placed behind the cipher letter it indicates that the car was forwarded. Abbreviations or symbols are frequently used for the initials of cars belonging to foreign roads most frequently handled. In many records no attempt is made to abbreviate road initials. It is customary to enter system cars in a separate book, and with such car records, initials are unnecessary.

In the record shown, car L. & N. 37,001 was received loaded from the Baltimore Division on Sept. 1. The entry is made on page 01 (the last two figures) in section 0, thus: $\overset{\text{L \& N}}{37}$ XA 9/1 as indicated on the portion of sample page shown. This entry indicates too, that there has apparently been no further or outward movement of this car. Other entries made show: L. E. & W. 27,101 received from Baltimore Division loaded Sept. 1 and forwarded by Omaha Division loaded Sept. 1; G. T. 2301 received loaded Sept. 1 from Omaha Division and forwarded by Boston Branch loaded, Sept. 2; So. 85,401 received empty from Boston Branch Sept. 4 and forwarded empty to the freight transfer platform; I. C. 27,701 received loaded from shops Sept. 4 and forwarded loaded to Baltimore Division Sept. 4.

The record kept by the New York Central at West Albany, N. Y., is a practical ready reference book, and economical to keep up. Through the West Albany yards, 32,782 eastbound and 35,140 westbound, a total of 67,922 cars, were passed during January, 1905, necessitating 135,844 entries, to cover "in and out" movements, besides the additional entries to cover two for each car sent out to transfer house, two for each car sent to shops, etc. The records are kept by four men.



600

CAR No.	INITIALS	RECEIVED			Destination	YARD RECORD				FORWARDED			INITIALS	RECEIVED			Destination	YARD RECORD				FORWARDED			INITIALS	RECEIVED			Destination	YARD RECORD				FORWARDED			INITIALS	RECEIVED			Destination	YARD RECORD				FORWARDED		
		DATE	FROM	TRAIN						DATE	TRAIN	TIME		DATE	FROM	TRAIN						DATE	TRAIN	TIME		DATE	FROM	TRAIN						DATE	TRAIN	TIME		DATE	FROM	TRAIN						DATE	TRAIN	TIME
50																																																
51																																																
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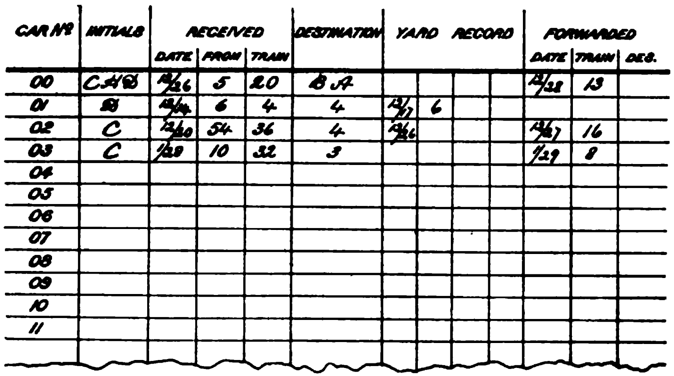
FIG. 74.—Sample page of New York Central car record book.



CAR No.	INITIALS	RECEIVED			DESTINATION	YARD RECORD				FORWARDED		
		DATE	FROM	TRAIN						DATE	TRAIN	DES.
00	CH&	12/26	5	20	B A					12/28	13	
01	B	12/24	6	4	4	12/27	6					
02	C	12/20	54	36	4	12/26				12/27	16	
03	C	1/28	10	32	3					1/29	8	
04												
05												
06												
07												
08												
09												
10												
11												

FIG. 75.—Details of book record of car movement.

Figures 74 and 75 show a part of a page of the record book. These books are paged consecutively from 1 to 1000, the two pages facing each other having the same numbers. These two pages have entry lines for each 100 cars so that a set of books will take care of 100,000 car numbers. The car record is made as follows: Suppose the number is 62,175, the entry is made in line 75, of page 621. Each line is doubled and has space for eight car entries, which allows for duplicate entries of the same numbers, whether they belong to a home car often repeated or to foreign cars. There are four sets of columns thus making space for eight car entries of each number, as indicated above. These book records contain the entries for the receipt of the cars and their delivery, and, in addition, show the delivery to and receipt from transfer house and other interior working points.

The conductor of a train approaching West Albany makes up the usual train or switch list which gives initials and numbers of cars in his train, contents, and destinations. On entering the yard, this list is handed to the "car markers" who go down the side of the train and chalk-mark each car in accordance with the list, and all switching is done by these marks. The lists are then sent to the yardmaster's office by a messenger, where the clerk checks off the cars and passes the list over to the record clerk who enters the car numbers in the record book.

The record for outgoing trains is obtained from a loose sheet made up by the number taker and sent in by a messenger. After the train is made up the number taker goes down the side and makes a memorandum of the car numbers and initials. After adding the train number, conductor's name, number of engine, and time of departure, this sheet is sent by messenger to the record clerk for outgoing entries. One clerk is employed continuously consulting the record books in connection with car tracers and to locate cars for the information of the yardmaster.

Empty foreign cars are frequently received without destination cards for home route delivery. These cars are recorded in a separate book with no special rulings and under numbered columns from 0 to 9, the last number of the car being the index number. Car 12,624 would be put in column 4. The superintendent of freight transportation or car accountant is then asked for the routing which, when it is received, makes it possible to cancel the record from the special book and transfer it to the permanent record.

For outgoing trains the car cards or tickets are assembled and slips made up, all being tied in a package in readiness for the conductor. He has nothing to detain him, and the train may then get under way quickly. This is a good arrangement and should be adopted in all yards with sufficiently heavy traffic movement to justify it.

The New Haven has adopted a standard record for its larger terminals, which being an adaptation of the general car service offices loose-leaf system, is economical and complete. The general office records consist of loose leaves put into a temporary working binder headed up as follows:

No. 00	Transfer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	etc. to 31
01																							
02 etc. to 99																							

This necessitates the use of a leaf for each month. In the terminals the date numbers are omitted, thereby enabling a leaf to be used until filled up—each movement of a car being entered as it moves—when the leaf is permanently filed and another substituted. This does away with the necessity of filing an entire book when some of the cars have their spaces filled up. Cars are entered by "terminal" numbers; car 10,510 being on page 105—opposite horizontal line 10. In the general office the movement is entered in the column under the date it moves; in the yard record the date and movement are written in.

A brief description of a system of checking car movements by the use of especially prepared cards is interesting, and while it is in no sense a substitute for a regular car record, is worth some study because of the good features it possesses. A case is used containing 100 pigeonholes labeled 0, 1, 2, etc., to and including 9 across and the same vertically. After a train has been entered up, a card is made for each car giving initial, number, date received, reference to page of entry, date outbound, engine, train, time, contents and destination. The ticket for each car is then placed in its proper pigeonhole. Car 43,228, for instance, would be placed in pigeonhole in row 2 (from top) and across in vertical row 8; that is to say in box 28. Any ticket may be found readily by looking over those in the box corresponding in number to the last figures of the car number. When the car has been forwarded the ticket is removed from the case and filed in a box containing six drawers, two compartments in each drawer, to provide a separate compartment for each month. Each compartment is provided with 100 pockets numbered in conformity with the original case to enable the tickets to be found more readily when necessary to refer to them.

For the special purpose of checking car movements in connection with per diem charges, one road uses a case divided into 310 pigeonholes, numbered from left to right, 1 to 31, indicating the days of the month. On the sides of the case are the numerals from 0 to 9 inclusive reading from the top down. A blank ticket, of suitable size, is made for each car giving car number, initial and date of arrival and such other information as may be deemed desirable. Car 27,342 arriving Oct. 10, would be placed in column 10 on line 2. The yardmaster can tell at a glance what cars are being delayed.

A bill rack may be so arranged as to enable a closer check to be kept than the last described plan. To accomplish this a "rack" should be made for each division, connection, branch or other forwarding destination. The case contains 10 boxes from left to right (horizontally) with five compartments in each or five boxes deep. The original or accompanying card tickets for the cars are placed in the boxes according to the last figure; those for cars arriving between midnight and 8 a. m. in the upper; those between 8 a. m. and 4 p. m. in the second tier and those between 4 p. m. and midnight in the third. Cars remaining over a day are then placed in the next tier—"yesterday"—and those two days or more old in the lower tier—"day before yesterday." The bill rack is made on the following plan:

New York Division

	0	1	2	3	4	5	6	7	8	9
12 midnight to 8 a. m										
8 a. m. to 4 p. m										
4 p. m. to midnight										
Yesterday										
Day before yesterday										

At midnight the bill clerk moves all bills or cards remaining in tier "yesterday" to the one just below and those from the three tiers above to "yesterday." Additional tiers may be added if deemed desirable. A glance will show any cars remaining in the yards more than 8 hours.

In connection with the last described system, or with any system, the use of a dating and timing stamp is valuable. A simple and cheap stamp is used having a time dial, which is set by hand just before the bills for an incoming train are distributed and with which each card ticket or bill is stamped. This records the yard, date and time and answers many questions. The clock time stamp is more expensive and also more likely to get out of order. It does not serve the purpose any better than the hand-set machine.

As the practice of rating locomotives on a tonnage basis is nearly universal, a considerable portion of the time of the yardmaster's force is taken up in computing the weight of trains, by taking the weight of each car plus contents when loaded, and adding them together. Much of the time of the bill clerks and train crews can be saved if tonnage-computing machines are furnished for this purpose. These machines have been in use at some heavy forwarding points and, while they will get out of order occasionally, are on the whole very satisfactory. In addition to saving time they insure accuracy and eliminate controversies between the train conductor and the yard clerk or yardmaster in which the conductor always thinks he has too much load while the yardmen think another car or two should be added. The yard clerk while adding up the weight of his car tickets is frequently interrupted by questions. The tonnage computing machine holds his place for him; that is to say, he may go to some other work and as soon as he returns continue on the machine just where he left off, provided he keeps the tickets counted separated from those not counted. The tonnage rating question has been discussed in Chapter X, where a description of one computing machine and its purpose will be found.

With a properly designed and operated terminal, where "hold" cars and "diversions" do not exist, where the conditions are ideal, the records may be dispensed with altogether. This necessitates a yard with double-end tracks, continuous in and out movements and ample of road power. The conductor of the incoming train hands or telegraphs the list of cars making up his train as they stand from the engine back. The ram or summit engine crews "cut" from this list and the signalman arranges the ladder switches from the same list. Cars for certain destinations are run into designated tracks and the signalman keeps a list of cars in each track by which the outgoing road power is ordered. The cars moved by an outgoing train are checked off; the date and time of that movement being added. Cars would always be moved in rotation, that is to say, the oldest cars would go out first.

The writer worked up a switch list form some years ago, to be used as an advance report of incoming trains, indicating the position of each car in the train. This was to be copied by the receiving operator on manifold paper and a copy furnished the "cutter" and others on the pole or summit engine. The form as given below was intended for a New Jersey terminal, and while not as full as others, seems to have some merit in simplicity and brevity. Columns for initials and numbers of cars could be added if deemed desirable. The following cipher code was printed on the inside front cover of each book of forms, and it will be observed that in "destinations" certain characters were used for connecting roads; others for Brooklyn deliveries; others for New York piers, etc.

A. B. & C. RAILROAD

..............................19....

Train............ *Eng*............ *Left*..........................

at..........*M. has*.....*cars*............................*tons, in following position from head end.*

.....................................*Engineman.*

.....................................*Conductor.*

	Lading	Destination		Lading	Destination		Lading	Destination
1			26			51		
2			27			52		
3			28			53		
4			29			54		
5			30			55		
6			31			56		
7			32			57		
8			33			58		
9			34			59		
10			35			60		
11			36			61		
12			37			62		
13			38			63		
14			39			64		
15			40			65		
16			41			66		
17			42			67		
18			43			68		
19			44			69		
20			45			70		
21			46			71		
22			47			72		
23			48			73		
24			49			74		
25			50			75		

CIPHERS USED

For Destination

BA—N. Y., N. H. & H. R. R.
BC—Long Island R. R.
BF—N. Y. C. & H. R. R. R. via 23d St.
BG—Erie R. R.
BH—West Shore R. R.
FC—Pier 44, N. R., New York.
FG—Pier 56, N. R., New York.
FH—128th St., E. R., New York.
CA—Palmer's Dock, Brooklyn.
CB—Brooklyn Wharf & Warehouse Co.
FA—43d St., E. R., New York.
FB—Pier 2, N. R., New York.
GN—Jersey City Engine-House.
GR—Jersey City Bergen Neck Power House.

F J—31st St., E. R., New York.
FK—39th St., N. R., New York.
GA—Jersey City Terminal.
GB—Jersey City Transfer Pier C.
GC—Jersey City Pier G.
GD—Jersey City Pier H.
GF—Jersey City Pier I.
GH—Jersey City Grand St. Coal Pockets.
G J—Jersey City Grand St. Yard.
GM—Jersey City Johnson Ave.
GS—Jersey City Johnson & Wilson.
GU—Jersey City Union Building Material Co.

HA—Oak Island Yards.
HB—Communipaw Abattoir.
HG—Eagle Oil Works, Communipaw.
HD—Standard Oil Co., Constable Hook.
HF—National Storage Co.

For Lading

A—Live Stock.
B—Live Poultry.
C—Dressed Beef, Meat and Provisions.
D—All other fast time freight.
F—Grain.
G—Flour.
H—Cement.
J—Pig Iron.
M—..............
N—..............
R—..............
S—..............
U—Coal.
W—All other slow freight.
X—Empty Refrigerator.
Y—Empty Produce.
Z—Empty Express.

Every yardmaster should personally keep a log record. In this all incidents out of the ordinary are recorded. Accidents of all kinds, unusual weather, inability to obtain necessary road or yard power, injuries to employees, obstructions on the main line and in fact anything that interferes with the smooth working of his yard should be noted. Questions will come up months afterward which, by reference to his log may be readily answered. Log records kept by train masters and chief dispatchers are invaluable.

CHAPTER XVI

WATER FRONT TERMINALS

The transfer of ordinary freight between rail and water and from rail to rail lines over intervening water, is accomplished:

(a) Car and load straight:
    By car floats or ferries, using float bridges to adjust for varying depths of water.
(b) Lightering:
    Transferring between car and vessel or pier, by using a barge or self-propelling vessel, as an intermediary.
(c) Car and vessel direct:
    Avoiding a second handling; either trucking freight to vessel or *vice versa*, or into and through a pier.

The bulk of the freight business in and about New York is handled on car floats. Some of these are of 12-car capacity, six on either side, with a center loading platform. The larger ones, used by the New Haven, New York Central and Pennsylvania roads, will carry 20 to 22 cars each. The float bridge must be constructed to accommodate itself to the varying levels of the car float, due to tides, which ranges from 4 to 12 ft.; and the difference in the depth of water drawn by the float itself, when fully loaded and when light. One end of the transfer or float bridge is usually supported by pontoons which keep it afloat and raise or lower the bridge with the tide. The view in Fig. 76 is that of a car float loaded, and being towed by a tug alongside.

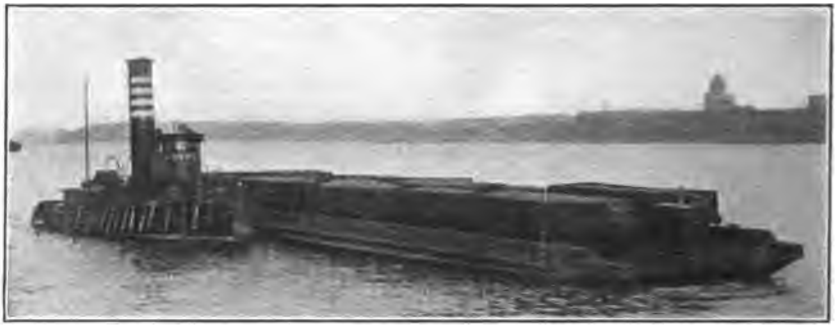


Fig. 76.—Loaded car float, in tow—New York Harbor.

The float is brought up to the transfer bridge and made fast by ropes or chains drawn taut by winches. There being one rope or chain at each side, they draw the float up snug so that the tracks on the float and on the transfer bridge are in approximate horizontal alinement. The final adjustment is made by a ratchet working a screw, by which the tracks on the bridge can be slid over a few inches. The bridge is raised or lowered before the float comes in, until the tracks are in approximate vertical alinement with those on the float. If the alinement is not accurate enough to slide the toggle bars on the bridge into the toggle caps on the float, time can be saved in adjustment by running the yard engine onto one of the bridge tracks, until its weight depresses that side far enough to let the toggle bar engage the cap. The locomotive is then moved to the other track and that toggle bar is made fast. A difference in height of several inches can be adjusted by this means in less time than if the float were lowered in the ordinary way. After the bridge has been used for some time, the toggle bars may have some play, so that the difference in the height of the rails on the bridge and on the float may be as much as 2 in. This being too much of a drop for the trucks of the tender to safely take, a flat car is coupled to the locomotive and backed up to the end of the string of cars on the float. Transfer bridges are usually double-tracked. When the float has three or more tracks, the tracks bend together with a crossing frog a few feet from the bow of the boat. The switch points are on the bridge. Many recently built bridges are operated by electric power, saving much time in raising or lowering bridges to make float fast.

It is a comparatively rare occurrence for cars to be lost from the floats while in transit; most of the accidents occur while at the dock. The engineman of the yard locomotive sometimes misunderstands or fails to obey the trainman's stop signal, if given, and backs a string of cars up against the bumper. If this holds, the force is usually enough to break the ropes which make the float fast and the float is driven out from the dock and the cars may be dropped between the bridge and the boat. Low bumpers are preferable, as the trucks of the last car will go over a low bumper and the car will come down on its body on the end of the boat. This is evident at once to the engineman, who stops the train before serious results ensue. Steel floats are flat on top; wooden ones are usually cambered to give them greater strength. For this reason, in case the float breaks loose from the dock while the cars are unsecured and the brakes off, the cars are more liable to move down grade from the middle of a wooden than from a steel float. Another advantage of the steel float is that the bow is not so bluff as a wooden boat; it has a long overhang and when there is ice at the pier it rides over it, instead of packing it up in front. The pontoon is weighted with rocks inside and kept as free from water as possible, so that its lifting power may be near the maximum, it being easier to let the float down than to raise it. When the pontoon is damaged, a rope is passed under the bridge at high tide and made fast to a gallows overhead. When the tide falls the pontoon drops with it and can be floated out from under the bridge and the necessary repairs made. The bridges are made very strong. They are hinged at the shore end so rigidly as to allow no torsion at that point. When heavy cars are run on one of the tracks, their weight warps the bridge, throwing an exceedingly heavy strain on the material of which it is made.

The steel barge "Mastodon"—of Morgan's Louisiana & Texas Company, for use in transferring passenger and freight trains across the Mississippi River, at New Orleans, shown in detailed drawings in Fig. 77—is said to be the largest steel barge in America; handles daily 16 passenger trains and more than 100 freight cars. It is constructed entirely of steel and carries three parallel tracks with 12-ft. centers. The length is 368 ft. over all; depth of hull is 50 ft., and depth at center 11 ft. 4 in. The principal figures relating to the construction are shown in the drawings.

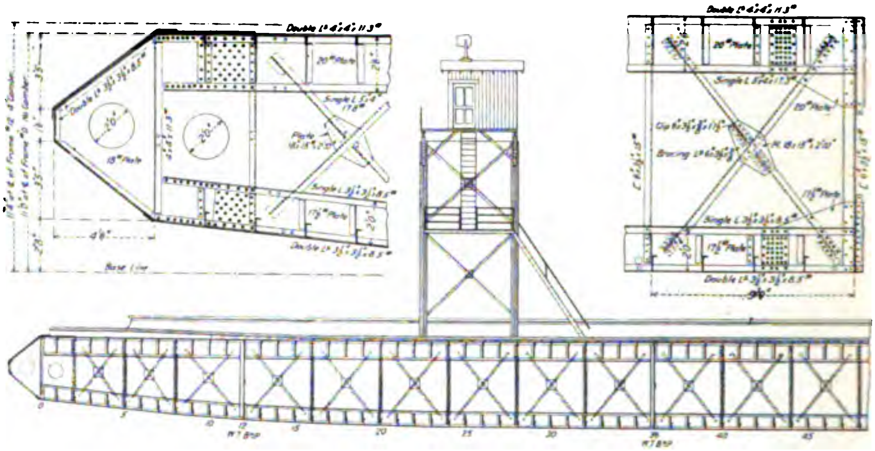


FIG. 77.—Framing of steel barge, "Mastodon"—Morgan's Louisiana & Texas Co.

The New Haven floats its cars between its terminals at Harlem River and Oak Point and its connections on the New Jersey coast, a distance of from 6 to 13 miles. It has in service, 46 floats, with a total of 771 cars capacity; 2 steamers and 19 tugs; and handles an average of 2000 cars daily. The estimated cost of ferrying a car 1 mile is 13 cents. The average cost of all lines is 48 cents, the highest $1.26. The Pennsylvania has 8 tugs and 60 floats with an aggregate capacity of 700 cars, and handles about 1000 cars a day. The New York Central has 20 tugs and 41 floats of 485 cars capacity; and handles about 760 cars a day.

The Long Island and the Baltimore & Ohio estimate their floating cost at 19 cents per mile; the Lackawanna, 60 cents; the Erie, 26 cents. The Norfolk and Western cost is about $1; the Northern Pacific, $1.26. The variation is largely due to slow or fast terminal handling.

A considerable amount of interesting information on the subject of piers for handling freight at water-front terminals is contained in the report of the Committee on Yards and Terminals of the American Railway Engineering Association, March, 1903, from which the following is quoted:

"*At large marine terminals,* whether ocean or lake ports, the railroad facilities for handling business differ very materially from those of inland terminals. At such terminals it is advantageous to unload into warehouses all classes of freight which can be placed on platforms, and only retain in the cars such classes of property as cannot be provided with housing accommodations. The great bulk of export and import freight is moved by lighterage service of the terminal railroad company. Where it is the practice to bring the ocean vessel to the dock of the terminal company, the agent has preliminary advice and is guided accordingly in making provision for the method he will adopt in furnishing service. The maintenance of special warehouses for export freight is not always essential, but the general warehouses employed for the unloading of lighterage freight can often be used also for export freight which is delivered direct to the vessel.

"It will facilitate matters if these warehouses are skirted with tracks on the outside, which, in turn, may be used to unload to or from the car, in addition to securing freight from the warehouse or discharging thereon. Greater economy in labor necessarily results if loading directly to and from the car can be brought about, and in a greater measure this suggestion permits either process to be employed in serving a vessel. A series of open docks is also essential for the handling of coarse freight, and also to extend the hoisting facilities operated by the terminal company in the interest of such vessels as have no means of taking on or discharging a cargo with their own power. In fact, open docks can be employed successfully for general cargoes usually loaded in box cars and the general trade transacted with small vessels and barges.

"*The facilities provided* at large seaport terminals are generally as follows:

"(1) A cluster or general yard, into which trains are moved; (2) lighterage piers, either open or covered, from which cars are unloaded or loaded to and from vessels; (3) export piers, from which freight for export is unloaded and transferred from vessels, or *vice versa;* (4) storage piers, in which is held (preparatory to being loaded on vessels) such freight as flour, machinery, lumber, provisions, canned goods, etc., the traffic rules allowing quite an amount of free time on this class of commodities; (5) inbound and outbound freight-station piers, located at points where they are only reached by water, and cars are moved to and from them on car floats. These are used for the city delivery or receipt of freight, and team-track delivery yards are provided in connection with them; (6) coal piers, upon which cars are run and unloaded into coal barges or vessels; (7) grain elevators; (8) warehouses; (9) stock yards.

"*The general yard or cluster* at a rail and water terminal is the large yard into which all business is moved. It should be so arranged that cars as they come in can be readily switched into the necessary classifications, which are usually as follows: Cars going to the export piers, storage piers, in- and outbound freight-station piers, team tracks, elevators, stock pens, etc., or to the yard from which the car floats are moved for making deliveries to other railroads in the harbor. This yard should be so arranged that the cars, after they are separated or classified as above, can be readily moved to the proper point (either the coal pier or the freight pier) without interfering with the other movements. The yard is not often so well developed as receiving yards at inland terminals because of the high value of terminal property at such points. As a rule the area or track room at a terminal does not increase in proportion to the growth of the other facilities. It should have a receiving yard, in which the trains on arrival are held previous to being classified. It should have a departure yard, in which the trains ready for movement are held. There should be caboose tracks so arranged that the caboose from an inbound train can be readily placed upon the rear or an outbound train. The movement of engines from the engine-house to the receiving or outbound tracks should be arranged to give a minimum amount of interference.

"*Covered lighterage piers* should be about 600 ft. long and about 125 ft. wide, with two tracks in the center, built at such an elevation that the floors of the cars will be level with the deck or floor of the pier. It is sometimes recommended that the sides of the pier should be composed of iron rolling or folding doors, but this feature does not seem to be desirable. It cuts down the storage space and very frequently it will be found that the post between two doors will obstruct one gangway to a lighter. Most lighters have but two gangways, and where a railroad company handles the bulk of its lighterage business, the lighters are usually built with a standard spacing for the gangways, so that the doors of the pier can be spaced to accommodate the gangways. There should be a platform 4 ft. wide, outside the walls, on the three water sides of the shed, the platform being provided with mooring piles or posts for securing vessels. Many of the older piers were built with sides having an inward slope or batter of about 1 in. to the foot, or usually about 3 ft. in the height. This was done so that in loading or unloading lighters the packages would not strike the sides of the building. This contingency is better provided against, however, by having a wider platform outside of the building, and in fact, practically all modern pier sheds are built with vertical sides.

"The shed or superstructure of the pier should be of steel frame construction or slow-burning mill timber construction. If wood is used it should be whitewashed, to prevent sparks from setting fire to it. In large cities the law usually requires steel construction. The roof should be designed to give as much light as possible during the day. This is preferably effected by means of windows on the sides of a monitor roof, and these may be supplemented by raised skylights or small monitors running transversely across the side slopes of the roof, parallel with(and between) the roof and trusses. Flat skylights are objectionable, as being liable to leak and to be damaged by storms or heavy snow. The monitor roof should have pivoted sashes to provide for ventilation, the sashes being handled by suitable mechanism. The shed should be lighted by electricity at night. It is important to provide good, smooth floors, and the lamp room should be thoroughly fireproof. The height of the floor above mean tide will vary with the kind of vessels to be handled and with the daily tide changes. These must all be carefully studied in order to arrive at the proper height above mean tide at any given location. Usually such height as will make the deck of the pier and boat at the same elevation at mean tide will be the most satisfactory. Between piers there should be a water space of about 200 ft. The tracks running into the piers should be so arranged that they will feed directly to and from the proper part of the general yard without interference. This type of pier will be often used for export business, and will then take on the features of an export pier and be built accordingly. In weighing freight, automatic scales are being used, and should result in a reduction of expense.

"Where heavy tides must be provided for, adjustable ramps or inclines should be introduced in the floor, the outer edge of the ramps being in line with the edge of the pier. By this means freight may be trucked to and from lighters at any stage of the tide without serious interference. The ramps are usually 15 to 20 ft. long, fitted with counter-weights and worked by a worm gear. Fixed ramps are sometimes used for convenient access to the lower decks of vessels.

"*Open lighterage piers* should be about 35 ft. wide and 600 ft. long, with a 6-ft. platform along each side. In many cases only two tracks are used, but long piers or piers which have more than two berths along each side should, however, have a third track, connected with the others by crossovers. This facilitates the shifting of cars and enables the berths at the outer end of the pier to be served without disturbing the work that is being done at the other berths. A pier with three tracks should be 45 to 50 ft. wide, and with tracks at least 11 ft. 6 in., center to center. The floor of the pier may be depressed so as to bring the car floors level with the 6-ft. platforms on each side. This, however, is not usually done.

"For most freight that is handled by derricks, the boom derricks on the lighters are used, but the pier should have a power crane or derrick of greater capacity for handling freight that is too heavy for the lighter derricks. This crane may either be stationary (in which case the lighter must be moved to the crane) or it may travel by power along the platform to any desired point. Traveling cranes of this type are extensively used at water terminals in Europe. Heavy freight, however, is usually handled by special lighters with powerful derricks, as the freight may have to be discharged at places where pier derricks are not provided. Stationary cranes for handling heavy loads, cases of glass, machinery, etc., are also of advantage. There is undoubtedly much room for the improvement of freight-handling facilities at piers, largely by the introduction of machinery for the purpose of effecting greater rapidity and economy than are possible under the common method of employing men with trucks or slow hand-winches and derricks. At European water terminals, traveling power cranes are extensively used along the sides of piers and docks.

"The piers should be built at such a height above water that cars to be unloaded can be most conveniently handled. A study of the tides and the free-board of boats is necessary to arrive at this height. Owing to storms and specially high tides it is necessary to build the piers at a height above mean tide slightly greater than that at which work can be done to the best advantage. There should be an open water space of at least 150 ft. between the sides of these piers. This space should prevent boats from being blocked in, and would give space for a tug with a lighter alongside to pass through two lines of boats and bring a barge from the bulkhead or land-end of the pier to the stream (or *vice versa*), without interfering with the loading of boats alongside the piers. Ample space will be found advantageous when the ice is running free.

"The piers should be so located that cars will feed directly to and from the proper part of the cluster or general yard with the minimum amount of interference. The pier is principally used for the handling of coarser products moving in gondola or flat cars. It is frequently built wider than described where stone, pig iron or other freight requiring storage on the dock is to be handled. These conditions, however, will vary with the conditions of each road. The pier above described is the type best adapted for the handling of such business as will not have to be unloaded and held or stored on the pier.

"*Export and storage piers* are constructed for ample storage, as well as for the economical working or handling of export freight. Under the traffic rules export freight must be held free of storage for 60 days. This is done to provide time for the arrival of steamers, or to make arrangements for the shipments. An export pier should be about 600 ft. long and about 125 ft. wide. On account of the great height of ocean steamers, it should usually be double-decked, the first-story deck having 20 ft. head room; second story, 18 ft.; height at eaves about 43 ft. The pier should be surrounded with a 6-ft. platform, arranged with the proper number of mooring piles for tying up vessels. The pier should be provided with a proper number of fire hydrants and a general system of fire protection, included in which a chemical engine is desirable. There should be two tracks running down the center of the pier, arranged at such an elevation that the floor of cars will be level with the deck of the pier. The house should be furnished with roof lights and electric lights, as already noted for lighterage piers. In fact, the general features and requirements for storage piers are similar to those of covered lighterage piers, already described.

"If possible, at east one track should be provided on the upper floor. In any case there should be a proper number of elevators for moving freight from floor to floor, and more elevators will be required if the second story is not provided with a track. In case flour is to be handled, and there is no track to the second floor, it will be found desirable to supplement the elevators by an endless barrel conveyor, such as is used in flour warehouses. The use of this type of conveyor is recommended for any special kind of commodity of which a great quantity is to be handled. Inclined chutes leading from a trap in the upper floor to the side of the pier may also be used for sending bagged flour direct to boat by gravity. The chute is hinged at the upper end, and its lower end has a telescopic portion which may be adjusted to deliver the bags where required. If bonded goods are to be handled, it will be necessary to divide off part of the house as a bonded warehouse.

"The double-deck pier has a number of advantages over a single-deck pier. The foundations are little, if any, more expensive, and it has approximately double the floor space, while, comparing floor space with roof, the cost is only one-half that of a single deck. The amount of real estate required is only about one-half. These advantages are great when the enormous value of terminal real estate is considered. Very frequently the second story of these piers is so arranged that immigrants can be handled in it.

"It is frequently desirable to have an open track alongside export piers, as the character of goods to be handled is often such that they can be unloaded directly to or from the steamer and the car. This applies where the commodity is bulky and can be loaded in open cars, and in such cases it is frequently desirable to have this track. It saves the handling of the goods to the floor and from the floor to the car, or one handling. At certain European ports various types of traveling gantry cranes are used, which greatly facilitate the handling of freight.

"The storage pier has many features of the covered lighterage pier, but it is designed primarily to accommodate the large ocean-going steamers, while the other pier is built to store only goods for harbor lighters. The export pier is for the handling of general export business. It often happens, however, that the business of one road will be very largely made up of flour, paper, tobacco, or some other special commodity. In such cases the description above will hardly answer, and the design is made to meet the special requirements of the traffic. In the case of flour, which usually has to be held a long time, the pier should be several stories high, and the stories should be only about 10 ft. high in clearance. Cutting down the height of the stories saves in the cost of the building; and also in the labor of tiering up freight to a great height. In the flour storage warehouses all floors are reached by elevators, usually hydraulic or electric, and by endless-chain conveyors. Each warehouse should have platform elevators to facilitate the handling of trucks, etc., from floor to floor. With these arrangements, goods can be handled to and from any floor at very little cost.

"Where a pier is built in this manner, it is usually called a storage pier, but it should have all the other features of an export pier. Export piers should be so located that tracks will lead directly to and from the proper part of the general yard with the least amount of interference.

"*Freight station pier and team track delivery.*—In many harbors there are freight stations having no rail connections, and at which freight is received and delivered by car floats. The piers at these stations should be about 600 ft. long and 125 ft. wide. This width will allow for a 35-ft. driveway in the center, and 45-ft. storage space on each side. Where the tides will allow it, the driveway should be located at a level about 2.5 ft. below the storage floor. In working out the height of the deck pier, the height of car floats, and fall and rise of the tide, and mean tide must be carefully considered. Ramps should be provided, as noted for open lighterage piers. The height of the abutting city street must not be overlooked, and the height that will require the least amount of work in handling freight under all conditions should be chosen. The pier should be surrounded on its three water sides with a 3-ft. platform, arranged with a proper number of cleats and mooring piles for tying up car floats. Along the water street should be built a bulkhead in connection with each pier 325 ft. long, to permit the tying up of two rows of car floats on each side of the pier.

"The pier will be used for inbound or city delivery freight, which in the morning will be moved from the cluster or general yard on car floats and placed alongside the pier. The cars are at once unloaded. Outbound freight will be received alongside the bulkhead and moved by trucks over the ends of car floats and on the platform between the lines of cars on each float. In this way none of the outbound freight will pass through the pier proper, and all interference will be done away with. Inconveniences will only be had when the inbound freight is arriving so late in the day that the outbound must be loaded at the same time. During the morning hours it is customary to store the outbound freight on the floor of the bulkhead until some of the cars containing inbound freight have been unloaded. It is then moved directly from the wagon as it is received over the scales and into the proper car.

"In the design of these piers the same principles and requirements must be considered as in the case of covered lighterage piers. It is especially important to provide them with fire hydrants and possibly a chemical engine. Adequate roof lights should be arranged for, the lighting at night to be by electricity. It is usually not best to double-deck the pier, but the bulkhead should be two stories high, the second story to be occupied by offices for the agent and his staff, and for the storage of records. Where much fruit is handled, it will also be necessary to provide an auction room on this floor for the sale of fruit. It will often be found necessary to provide a water tank at the extreme end of the pier for supplying tugs with water. Alongside the roadway, leading into the pier at the front end of the bulkhead, should be provided a small office for use of the cashier in issuing freight bills. This will do away with the necessity of teamsters going to and from the office on the second floor to pay their freight and leaving their teams unprotected and blocking the driveway. It will be found to greatly expedite the movement. Scales for weighing freight should be provided at proper intervals along the bulkhead, with small houses in connection with each for the receiving clerks and the weighmasters. These piers are frequently divided up alphabetically, so that the goods for any person can be easily found. At some other points this classification is made by commodities, eggs being unloaded at one location and glass at another. Water-closets should be provided both on the office and on the lower floor. A lamp room is usually necessary, as it is difficult to reach the cars on car floats with electric lights, so that lanterns are generally used. This room should be as fireproof as it is possible to make it.

"Similar accommodations can be had by buying a block of property and building upon it the usual inbound and outbound freight stations, arranging the tracks from them to lead to a transfer bridge, so that cars can be moved between the freight-houses and car floats. For operating the yard it will then be necessary to provide a small dummy engine, or handle the cars by electric power. The team tracks at such points are usually arranged in pairs, with the proper space for roadways. These tracks connect with ladder tracks leading to the transfer bridge. The arrangement will depend largely upon the shape and size of the property acquired."

As water-front space increases in value, particularly at harbors on tide-water coasts, the practice of building two- and three-story freight piers is becoming general. With the use of elevators, freight can be moved, readily and quickly to or from any story, and, considering the value of ground space, the cost of elevating, with the improved machinery in use and the application of electric power, is often less than the interest on additional ground space needed.

The Lehigh Valley at its Jersey City terminals, has had two-story freight piers in use for over 15 years and during the past few years it has built two three-story piers. The dimensions are 130 × 570 ft. and freight is moved to and from the upper floors by electric elevators. Electric power is obtained from a city plant and, while the prices are rather high, the cost for current during the average month was 13 cents per car handled; some of the freight going to the second and some to the third floor. Most of this freight was flour, in sacks and barrels. The truck haul is shorter than if the same area was contained in a single floor. For handling general freight a system of inclined endless-chain moving platforms—something like the escalators in large department stores and at some of the elevated railroad stations in New York—might be advantageously adopted. Platforms of this kind are in use in some freight piers for unloading and loading vessels, and are arranged so as to permit their removal or adjustment to different positions or elevations.

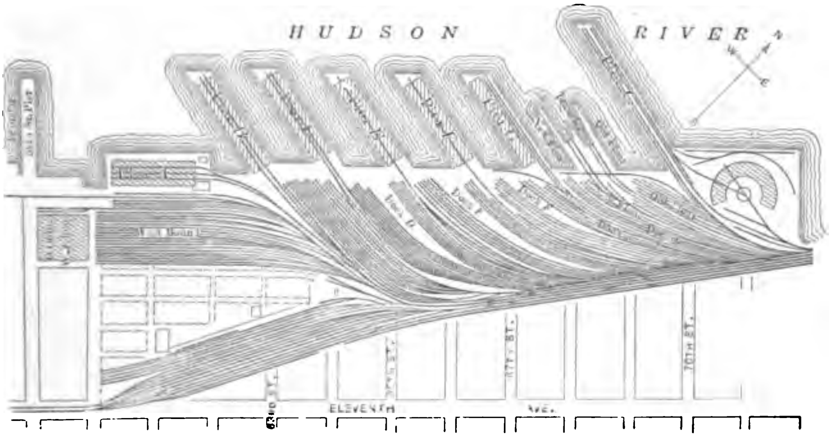


Fig. 78.—Plan of yards and piers, East 69th Street, New York City—New York Central.

Fig. 78 shows a modern type of a freight delivery, water-front pier and float-bridge arrangement, at a point where property values are high, that of the New York Central yard at 69th Street, New York, extending from 60th to 72nd Streets along the North (Hudson) river. It includes an elevator, six piers, a transfer dock, and an engine-house, with the usual minor structures, and has a large storage capacity for freight cars.

The plan shows the freedom with which all tracks on the piers and transfer docks may be approached from the main track, and how the remaining space has been ingeniously used for storage tracks. A general view is shown in Fig. 2, page 4.

The Pinner's Point terminal of the Southern Railway near Norfolk, Va., (Fig. 79) represents a fair development of a tide-water frontage where ample space was available and where land values were moderate. A large proportion of the freight handled through this terminal is cotton.

The Bush Terminal in Brooklyn is also a tide-water front delivery yard where every available foot of space had to be utilized to its utmost because of the high values of property.

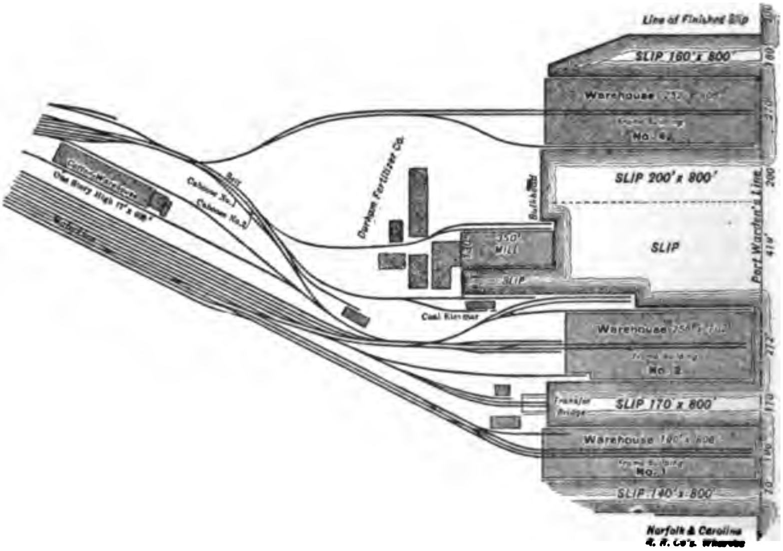


FIG. 79.—Plan of yards and piers, Pinner's Point, Va.—Southern Railway.

The photograph in Fig 80 is that of one of the large piers of the Bush Terminals in Brooklyn. A general plan, view of a typical water scene, end view of warehouses and bird's-eye view of yards are shown in Figs. 81, 82, 83 and 84.

The cut in Fig. 85 is the Cunard Dock, New York, with one of its newest and largest ships alongside. New York City collects upward of 5.5 millions a year in rent for its docks.

An interesting and extensive water-front development (shown in Fig. 86) is that of the Louisville and Nashville at Pensacola, Fla., consisting of several modern and well-built wharves, of which the Muskogee, is used mostly for coal, phosphate, rock and lumber. It is 2440 ft. long, 120 ft. wide at the sea end and 46 ft. wide at the shore end. On the lower level are five tracks and on the coal trestle above are two. The trestle has 13 coal chutes and 4 grain chutes. These are hinged so that they may be drawn up out of the way when not in use. They have extension aprons to accommodate the hatches of vessels of any size. Coal cars are run out on the outer of the two elevated tracks, unloaded through the chutes, and then moved to a transfer table at the end of the trestle, going back on the inner track to the railroad yards north of the wharf. Phosphate rock is loaded in the same way. Vessels may be loaded from cars on the upper and lower tracks at the same time, taking on bunker coal while loading cargo, or taking coal or phosphate rock through the chutes and miscellaneous freight from other cars on the lower tracks. Lumber is also loaded direct from the cars. Timber is usually unloaded into the water from skids near the shore end of the wharf and held in booms until needed. The sectional view in Fig. 87 clearly shows the construction plan and operating methods.

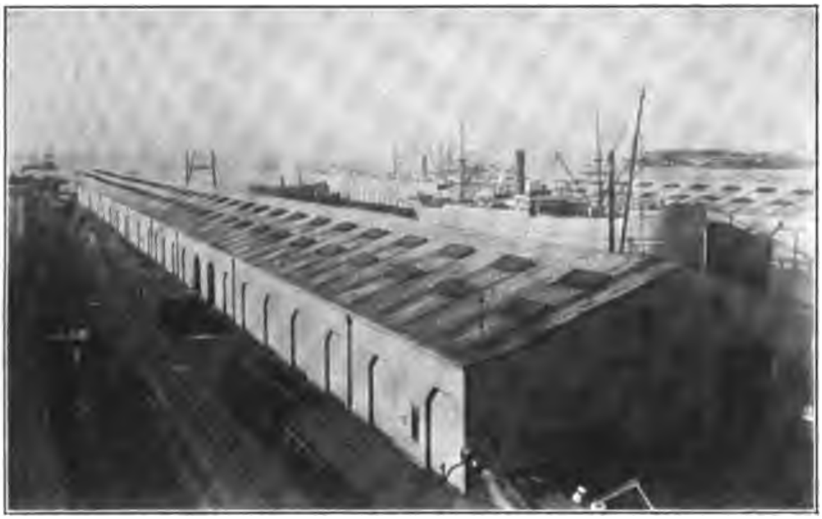


FIG. 80.—Covered pier of Bush Terminal.

The Tarragona and the Commandancia Street wharves (Figs. 88 and 89) are about a mile west of Muskogee Dock. They are parallel to each other, with a slip about 160 ft. wide between. Tarragona is 1950 ft. long. At the shore end is a grain elevator of 500,000 bushels capacity. A belt conveyor runs from the elevator to the outer end of the wharf through a conveyor gallery. There are two belts, each designed to deliver 10,000 bushels of grain per hour. Along the west side of the wharf are 27 grain spouts, through which grain is delivered to the holds of the vessels. Grain can thus be loaded from both belts to one hold or separate holds of the same or different steamers. There are two warehouses on the dock; the outer one is 50 ft. wide and 404 ft. long, divided into 11 compartments, and is served by a Hunt elevated automatic railway. The other is 50 ft. by 140 ft. On the west side are two tracks.

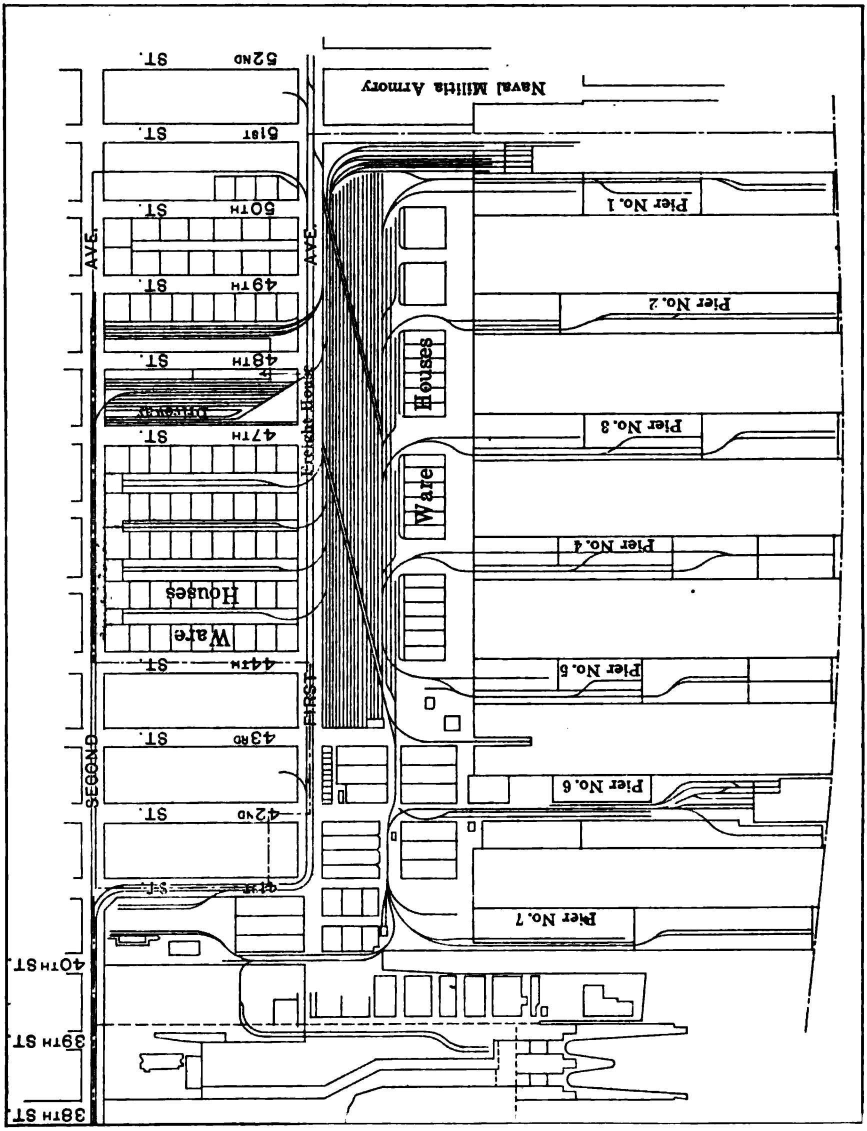


FIG. 81.—General plan, Bush Terminals—Brooklyn, N. Y.

The Commandancia Street wharf is the newest—110 ft. by 2075 ft. The warehouse is a two-story building, 50 ft. by 1200 ft. Alongside of it, on the upper story, there are two railroad tracks, one on each side, and on the lower story there are three. As at the Tarragona Street wharf, vessels can be loaded from either the upper or lower floors or from both at once, and at the same time take on bunker coal. The warehouse has 400 doors—each 8 ft. wide, opening vertically. Both floors are designed to carry 600 lb. per square foot.

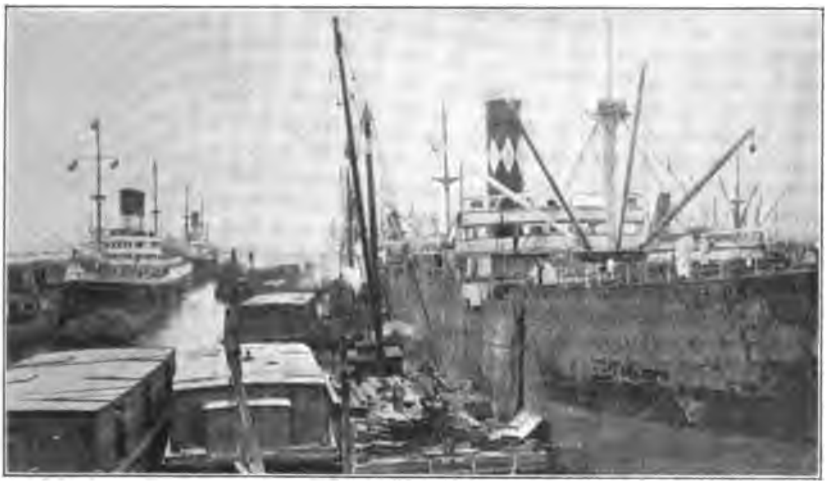


Fig. 82.—Typical water-front scene—Bush Terminal.

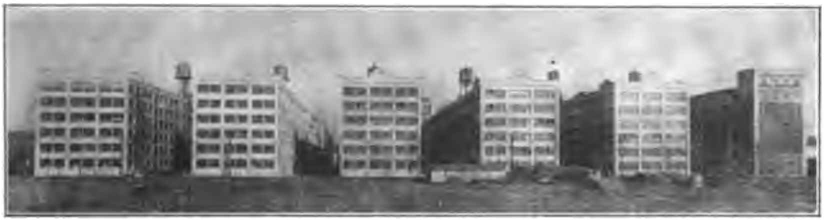


Fig. 83.—Warehouses of Bush Terminal.

A bird's-eye view of the East Boston, Mass., water-front terminals, of the Boston & Albany, is shown in Fig. 90. In July, 1908, the plant, with the exception of one dock and two warehouses, was destroyed by fire. The present terminals cost 4 million dollars, and covers about 50 acres of land.

The new piers are 780 ft. long, 240 ft. wide; the slips between are from 200 to 250 ft. wide with sufficient water to berth the largest steamships at low tide. Ships of the Cunard and Leyland Lines, operating between Boston

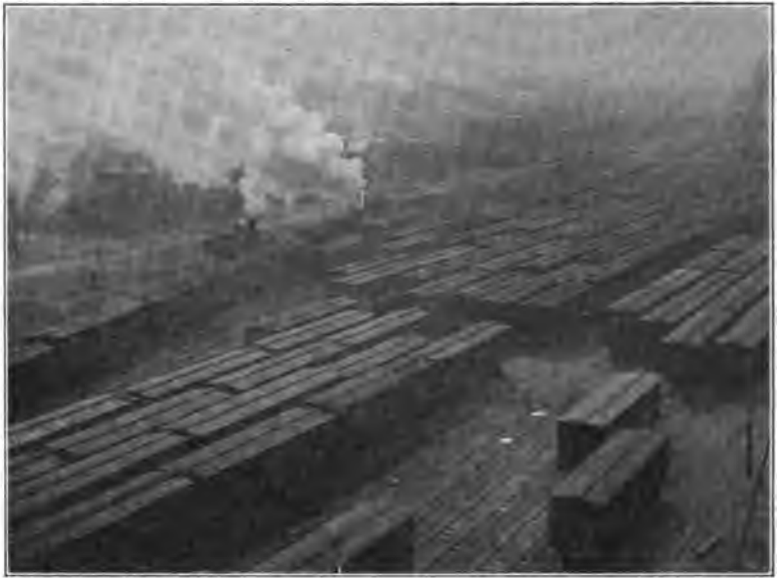


FIG. 84.—Yards of Bush Terminal.

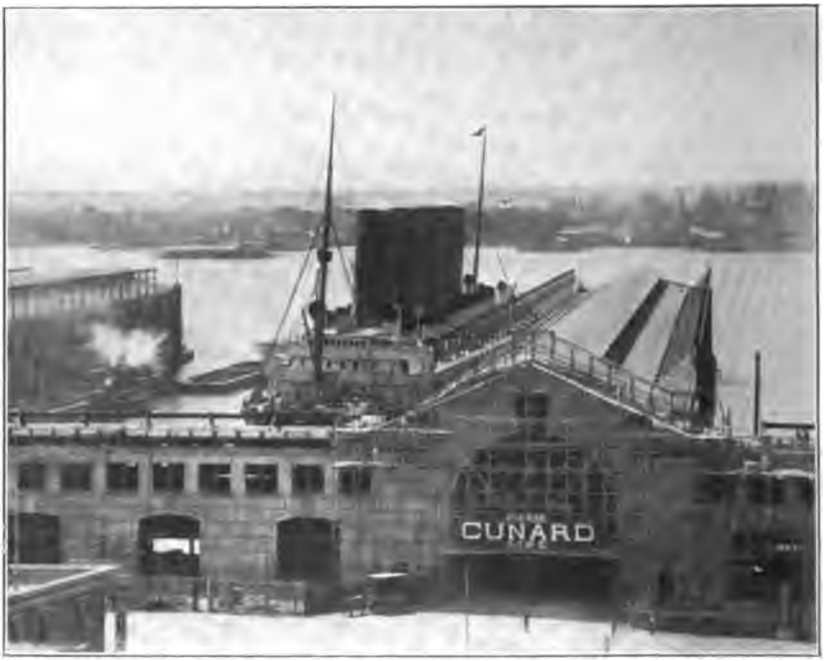


FIG. 85.—Cunard dock, New York City, with one of the large Cunarders alongside.

and London, Boston and Liverpool, and Boston and Manchester dock here. The new grain elevator and dryer—the largest in New England—has a capacity of 1 million bushels and cost 1 million dollars. The elevator is fire-proof and electrically operated. Conveyors run directly along the sides of the piers, insuring quick and easy delivery to the ships. The building is 269 ft. long, 73 ft. wide and 185 ft. high, and rests on foundations of reinforced concerete under which are 2600 piles. These are 192 steel bins. On the water side of the elevator are the bins from which the conveyors, which are on belt system, distribute the grain to the ships. The piers at East Boston are the largest used for commercial purposes on the Atlantic coast except the new docks at Brooklyn. They are accessible for the largest ships, there being from 36 to 40 ft. of water in the slips and the berthing and warping-in of a large ship is easily accomplished. On Pier 3, there are large rooms where incoming passengers of all classes can be easily handled, and here the United States Custom House inspectors, quarantine officers, and immigration officials have their quarters.

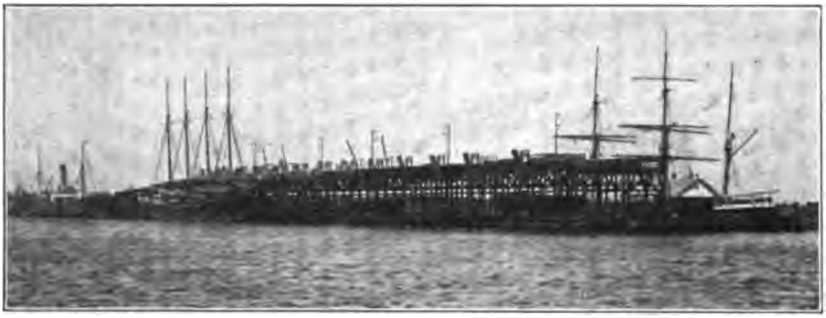


FIG. 86.—Coal, grain and lumber dock, Pensacola, Fla.—Louisville & Nashville.

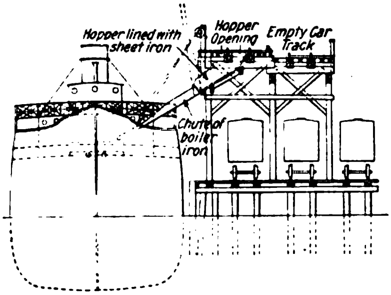


FIG. 87.—Sectional view, Muskagee dock, Pensacola, Fla.—Louisville & Nashville.

At Superior, Wis., the double-deck flour pier of the Great Northern, 127 × 1800 ft., handles from "house to boat" between 650,000 and 750,000 tons annually. About 80 per cent. of its business is east-bound and 60 per cent. of that is flour. Tracks are laid on both floors.

The Northern Pacific pier at Duluth is single-deck, measuring 80 × 1700 ft.

An interesting water-front terminal is shown in Fig. 138, on insert opposite page 298; that of the New Haven at South Boston, Mass. While it is a very important water-front development, its freight-house features are of greater importance and it is therefore treated under that head.

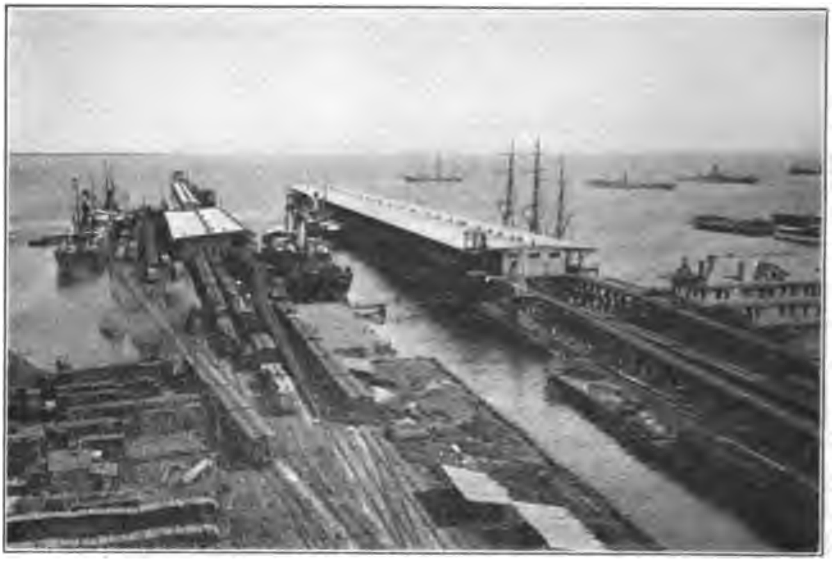


Fig. 88.—Land-end view of Commandacia and Tarragona docks, Pensacola, Fla.—Louisville & Nashville.

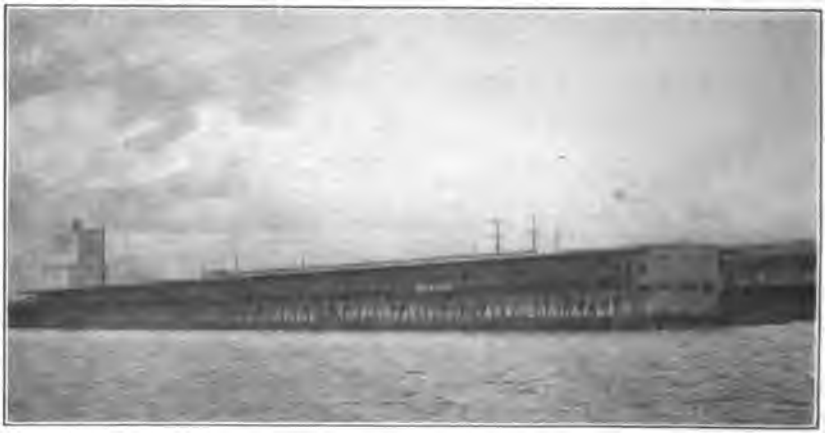


Fig. 89.—Water end view of Commandacia and Tarragona docks, Pensacola, Fla.—Louisville & Nashville.

Duisburg-Ruhrort (just below Düsseldorf) is the chief port on the Rhine, Germany, and perhaps the most highly developed water front in the world. It is the river portal of the Rheinish-Westphalian coal and iron district. In 1907 the river traffic of the Rhine amounted to 64.5 million tons. The Duisburg-Ruhrort port handled that year 21.5 million tons, compared with 20.8 million tons merchandise entering and leaving Hamburg the same year. The German railroads always arrange physical connections withthe waterways if desirable, the river ports are usually maintained by the cities but in some cases by the state railroads. The factors entering into and largely controlling the future of inland waterways and which are highly developed in Germany, are free open rivers, with a fine adaptation of their floating stock to the local conditions; good river terminals, with facilities for easy exchange of freight between inland water and rail carriers; a degree of co-operation between railroad and river making possible the combined shipment on which a dense river traffic depends.

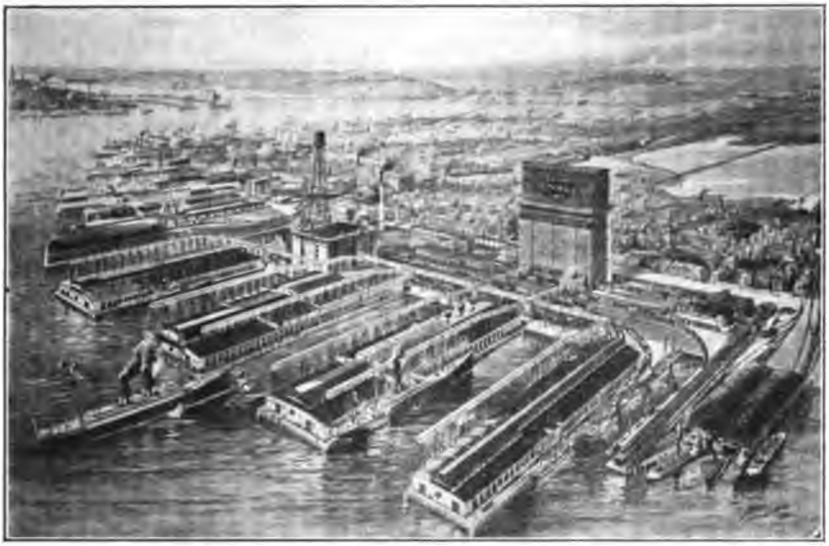


FIG. 90.—Water-front terminals, East Boston, Mass.—Boston & Albany.

The typical Rhine barge of to-day has a capacity of about 1500 tons; it is 250 ft. long, 35 ft. wide, has a loaded draught of 8 ft. and costs approximately $22,000. Screw towing steamers, are used on the lower Rhine, and for the shallower portion above Cologne (210 miles from the sea) a long shallow-going side-wheel tug of 1200 h. p. is preferred. This will tow 6000 tons of cargo up stream in a barge tram at 3 to 3.5 miles per hour, and costs in the neighborhood of $90,000.

CHAPTER XVII

COAL PIERS, AND STORAGE PLANTS

Piers at which coal is transferred from cars to boats or from boats to cars are located at many tide-water and fresh-water points and are equipped with mechanical appliances to facilitate rapid and economical movement. Where power plants or retailing plants are located on the water front, the coal is usually discharged from vessels directly into storage bins or coal bunkers. It is a comparatively simple undertaking unload coal from cars to vessels and, with proper facilities, the cost need not exceed a fraction of a cent per ton. For economical and rapid handling, the highest development is in the air-dumped car, by which the engineman can in a few minutes dump his whole train load through chutes into vessels. With the machinery in use on the great lakes, and at Hoboken, N. J., (Lackawanna road) an entire loaded coal car is picked up, elevated and its contents dumped bodily into the vesel alongside.

Discharging from vessels to cars is more complicated and costly. Usually a charge of from 20 to 25 cents per ton is exacted for this service. The actual cost with the best equipped plants will vary greatly, being influenced by character of vessels used, unloading machinery, reliability and kind of labor, etc. The usual method of wearing out old vessels or barges in the coal-carrying trade increases the discharging expense by reason of the "between decks," small hatches, deep keels with cross bracing, etc., as in such cases a very large proportion of the coal cannot be reached by the clam-shell or orange-peel grab buckets and has to be gotten out by "trimmers"—that is, shovelers who fill tubs which are afterward hoisted. Frequently the tubs have to be wheeled some distance to reach the hatches.

The annual output of coal in this country is approximately 487,000,000 tons of 2000 lb., of which nearly 17 per cent. is anthracite. Pennsylvania produces the only anthracite, about 80,000,000 tons, and nearly 144,000,000 tons of bituminous coal. Illinois produces about 50,000,000 tons, and West Virginia nearly 60,000,000 tons of bituminous.

The Norfolk & Western handles bituminous coal exclusively and has a heavy traffic. Lambert's Point, near Norfolk, Va., is its tide-water terminal, and the coal pier for handling coal from cars into boats is shown in Fig. 91.

This steel pier is 866 ft. long with unloading tracks throughout its entire length. It has an average height of 70 ft. above high water and

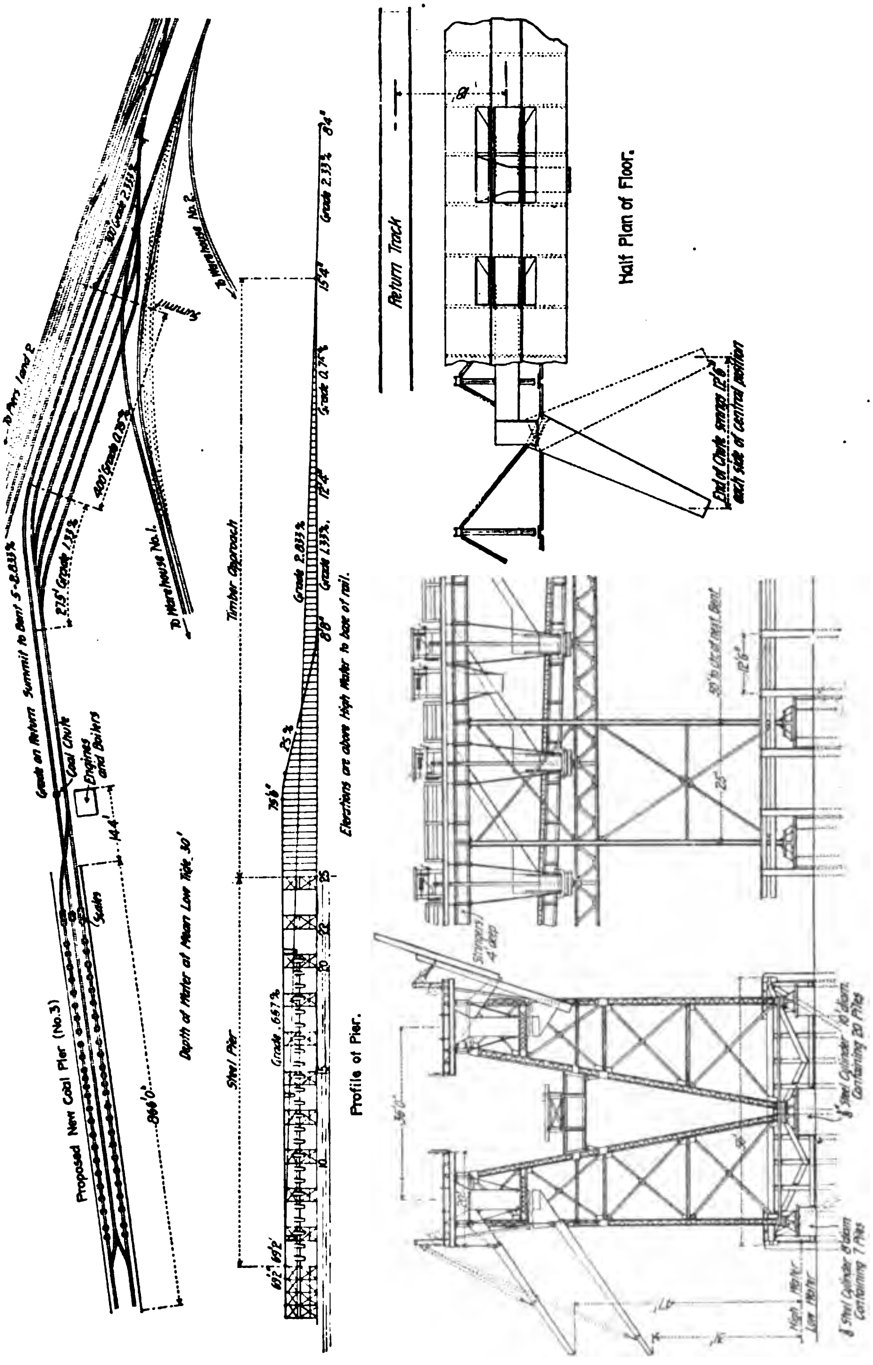


FIG. 91.—Coal pier at Lambert's Point, Va.—Norfolk & Western.

accommodates ocean steamships. It has 54 chutes through which coal or coke can be loaded into the largest vessels. Loaded cars are hauled up the 25 per cent. incline leading to the entrance of the pier, by a stationary engine, working a cable, and from the top of this incline the cars are dropped by gravity, both going and returning.

The Curtis Bay coal dock of the Baltimore & Ohio near Baltimore (Figs. 92, 93 and 94), handles bituminous coal only. This dock is 800 ft. long from the shore line to the deep-water end where it is 45 ft. high—the width being 60 ft. The approach is 1000 ft. long, giving the incline a grade of about 2 per cent. This approach track rises from a yard which has a capacity of 2600 cars. At the top of the incline the cars are run over a 100-ton track scale. One of these scales is located in each of the two tracks and they weigh automatically. There are 100 unloading pockets of 180 to 350 tons capacity each. After the cars are dumped they are run by gravity to a switchback at the end of the dock where they are shunted to the return track and down the empty-car incline, 1800 ft. long, to the yard and are again automatically weighed while in motion. The combined unloading capacity of the several old docks at Locust Point, Baltimore, was approximately 8000 tons in 10 hours when cars of 25 to 30 tons capacity were used. With 50-ton cars the unloading capacity of the Curtis Bay dock is estimated at 10,000 tons, when vessels are at hand to receive cargoes.

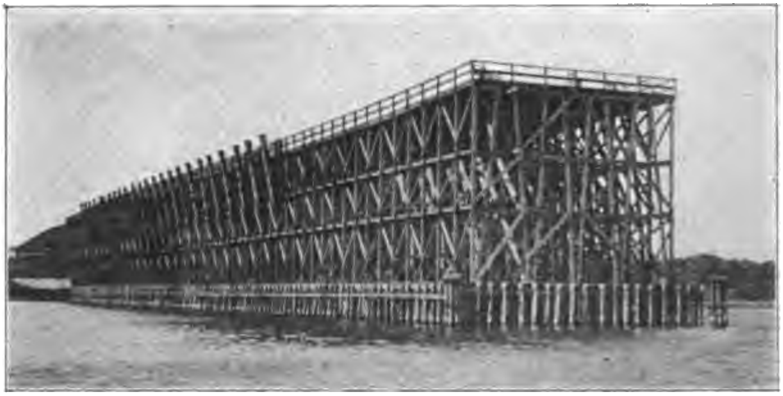


FIG. 92.—Curtis Bay pier—Baltimore & Ohio.

At the new terminal at Port Covington of the Western Maryland, a large coal-handling pier 750 ft. long and 60 ft. wide has been built. This pier is equipped with 20 coal chutes on each side, in which the cars discharge the coal directly to the holds of the vessels lying alongside. The tracks on top of the pier are 70 ft. above mean low water.

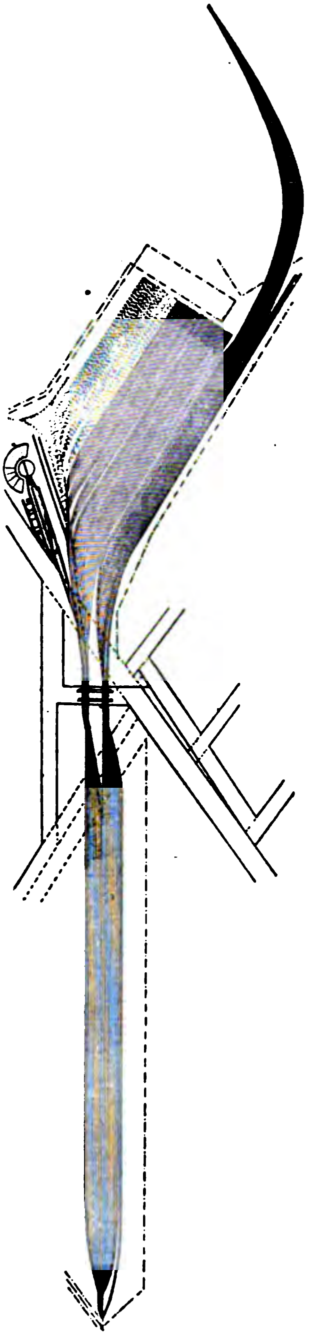


FIG. 93.—Plan of coal yards at Curtis Bay, Md.—Baltimore & Ohio.

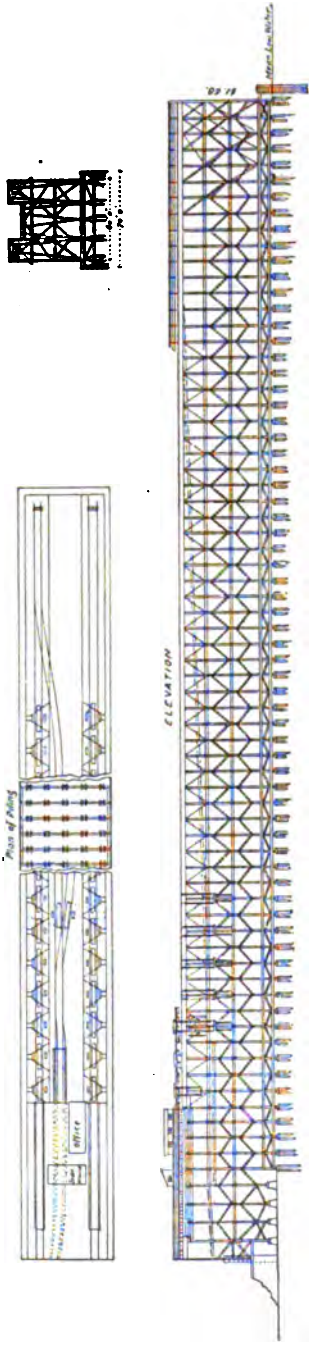


FIG. 94.—Plan and elevation of coal pier at Curtis Bay, Md.—Baltimore & Ohio.

There are two outbound and two inbound tracks, the latter being in the middle. Loaded cars are hauled up the incline on the inshore end by a "barney," power being supplied by a hoisting engine placed directly under the incline. It is estimated that the cars can be carried up this incline and unloaded at the average rate of one a minute. At the extreme end of the pier are two turntables which are used to transfer the cars as soon as they are emptied, from the outbound tracks to the inbound tracks, where they run by gravity down to the yard. Two track scales, one for loaded cars and the other for empty cars are placed just beyond the "barney" pit, so that the cars can be weighed without delay. A photograph of the pier and a track plan are shown in Figs. 95 and 96.

The table on page 247 of the largest coal piers in this country is in convenient shape for those who may desire to give this subject more study.

In discharging coal from cars to vessels, directly or indirectly, it is necessary to build piers to a considerable height above the water. There is much variation in the height of vessels to be loaded. The coal may be dumped directly from a car into a chute which in turn dumps into the hold of the vessel, or it may be dumped into pockets and later on be drawn from the pockets into the vessel's hold, when the vessel arrives which is to take that particular kind of coal. Usually chutes are made to be raised or lowered to reach the proper part of the vessel. In handling anthracite coal, screens are added to separate the dust from the coal.

Ordinarily coal piers are made up of three tracks, the two outside ones for loaded cars, which, after being unloaded, are moved ahead and switched to the middle track, dropping back by gravity to the empty car yard. The grade of the loaded car tracks should descend sufficiently toward the outer or water end of the pier to enable the cars to be moved easily and the grade of the middle or empty car track should drop in the opposite direction so the empty cars after being transferred thereto, will return to the land end of the pier by gravity. This enables rapid and economical handling. On exceedingly long piers five tracks are used, with suitable cross-overs, so cars can be moved around those unloading at any particular berth.

A number of coal pockets can be provided, spaced the proper distance, so that each of a string of cars may be unloaded. To allow for unequal lengths of cars the distances between centers of pockets should be that of the longest car, or preferably, a little greater.

The water space on each side of a pier or between piers, should be about 150 feet, so that vessels may be docked with a tug, turned or run by others already docked. Platforms or walks should be built around the pier so that men may walk from car to car, without using tracks; suitable railing should be provided for their safety. Mooring piles are necessary at intervals alongside the piers for tying up coal barges. The

TABULATED SUMMARY OF RAILROAD COAL PIERS

Railroad and location	Date when built	Size, feet	Method of elevating cars	Per cent. grade on approach	Grade of delivery tracks		Grade of return tracks		Height		No. of tra'ks on upper deck	No. of return tra'ks
					No. of tra'ks	On pier, per cent.	On pier, per cent.	Beyond pier, per cent.	Shore end, feet	Sea end, feet		
N. Y., O. & W., Cornwall, N. Y.	'92	About 50×700	Inclined plane Sea end.	....	1	....	....	....	....	....	4	2
P. R. R. No. 5, Greenwich Pt., Phila.	'88	56×650	Loco. incline Shore end.	About 2.	1	0.3	0.3	2.0	28.	30.	4	2
P. R. R. No. 6, Greenwich Pt., Phila.	'02	735×50–60	Cable incline sea end.	17.5	3	1.0	2.8	1.5	65.	57.5	2	1
N. Y., S. & W., Cliffside, N. Y.	'93	65×957	Inclined plane	20.	2	0.87 1.22	2.08	....	31.7	25.	4	1
P. & R., Port Richmond, Phila.	'93	About 54×700	Loco. incline	2.95	2	1.39	1.39	....	....	About 23.	.....	.....
P. & R., Port Richmond, Phila.	'98	55×761	Loco. incline	1.25	.....	1.25			43.4		4	
P. & R., Port Reading, N. J	'91	56 wide	Loco. incline	3.	2	1.33	3.0		36.	19.	4	2
N. & W., Lambert's Point, Va.	'90	About 50×805	Loco. incline	2.5	1	0.732	2.5	1.0	42.	35.	2	1
N. & W., Lambert's Point, Va.	'02	56×850	Inclined plane	25.	2	0.667	2.833	2.833	72.8	74.6	2	1
D. L. & W., Hoboken, N. J.	'03	1283×60–72	Gravity	1.	.....	Level	1.0	1.0	4.5	4.5		2
C. R. R. of N. J., Jersey City, N. J.	'87	38 wide	Loco. incline	2.64	2	1.46 1.38	3.0		29.	20.6	2	1
D. & H., Weehawken, N. J.	'87	....	Inclined plane	17.5	1	1.04	1.74		35.		4	1
B. & O., St George, S. I.	'92	About 300 long	Loco. incline	....	1	Level						
B. & O., Phila., Pa.	'93	40×700	Loco. incline	2.	2	Level			18.5	18.5	2	1
B. & O Curtis Bay, Balt.	'00	800×60	Loco incline	1.5	2	1.5	2.5	1.0	45.	45.	2	2
Erie, Weehawken, N. J.	'91	....	Inclined plane	20.	2	0.87 1.22	1.4		36.	26.5	4	1
L. V. R. R Pier A, Perth Amboy, N. J	'86	70×800	Gravity	0.6	4	0.6	1.0		29.5	25.	4	1
C & O., Newport News, Va.	'82	44 wide 275 long	Loco. incline	2.03	2	0.9	0.6			22.	2	1
D. L. & W. Pier No. 10, Hoboken, N. J.	'84	64×995	Inclined plane	16.	2	1.0	0.8		35.	25.	4	1

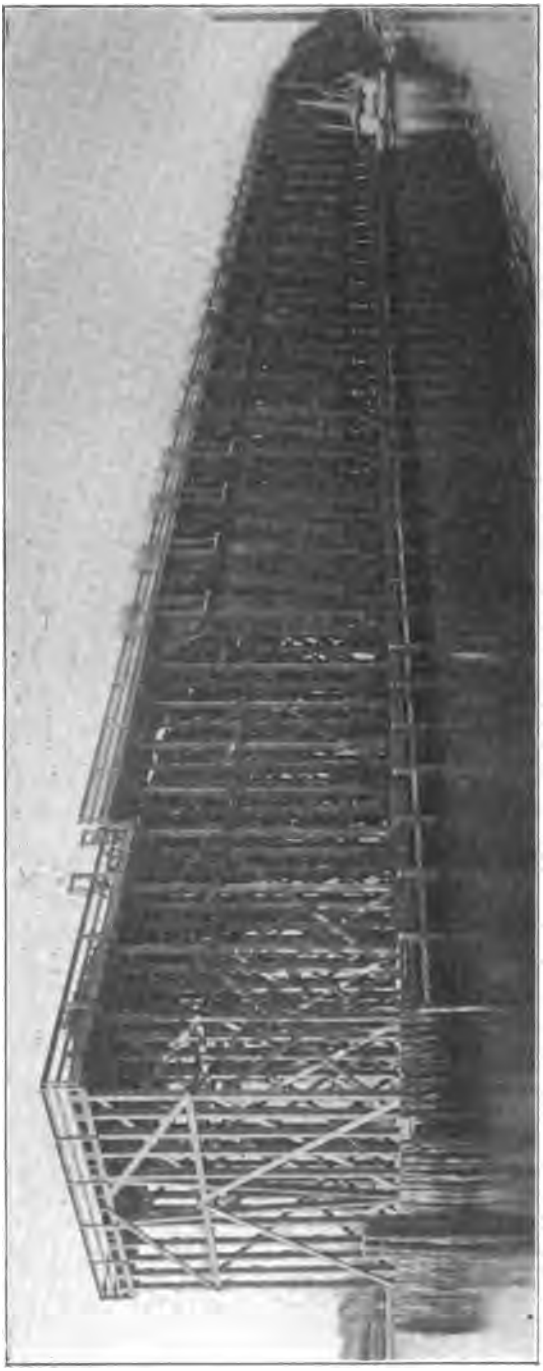


Fig. 95.—Coal pier, Port Covington, Md.—Western Maryland.

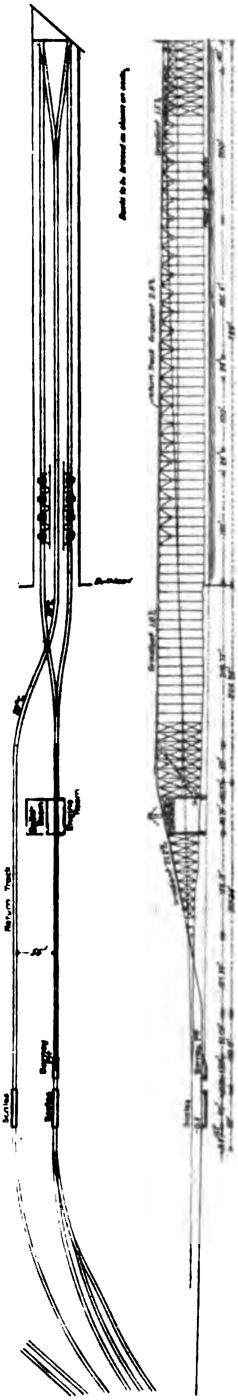


Fig. 96.—Plan and elevation, coal pier, Port Covington, Md.—Western Maryland.

plan, side view, longitudinal and transverse sections, shown in Fig. 97, are those of a standard tidewater coal pier recommended by the American Railway Eng. Association.

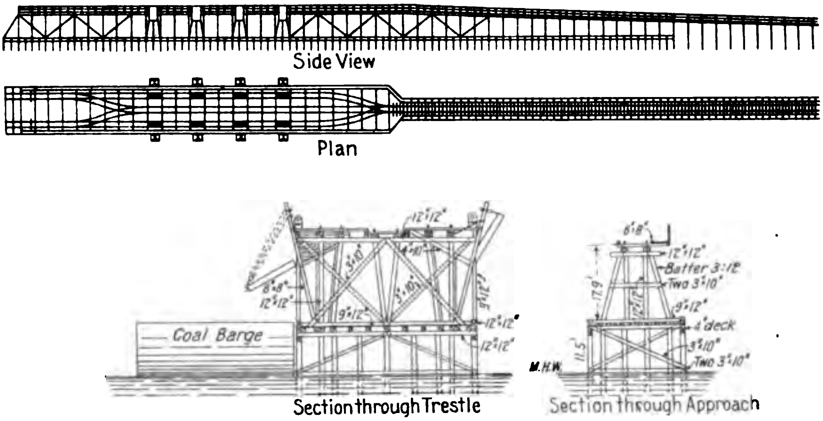


Fig. 97.—Standard tide-water coal pier—Am. Ry. Engineering Ass'n.

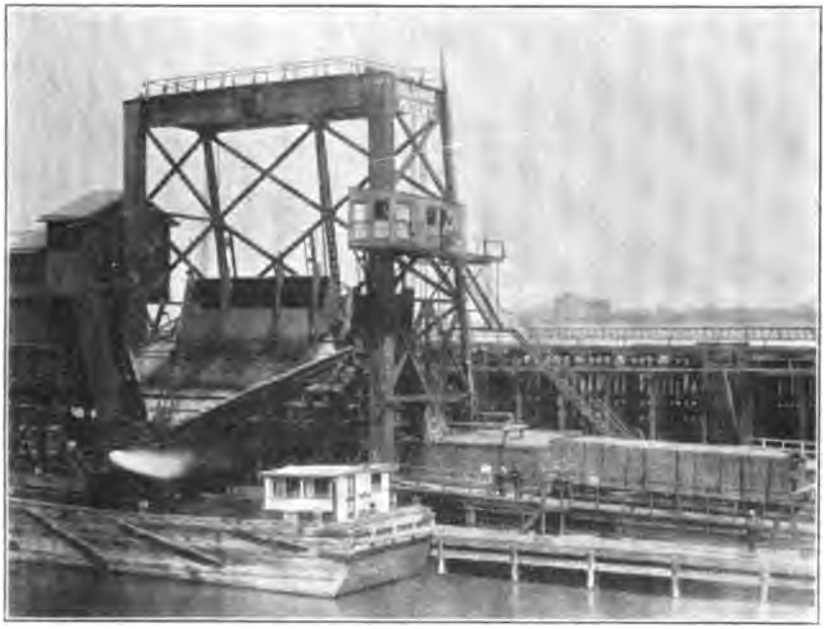


Fig. 98.—Car dumping machine, Hoboken, N. J.—Lackawanna.

Fig. 98 is a view of a car dumping machine of the Lackawanna at Hoboken, N. J., especially constructed for handling anthracite coal and is provided with screens and an elevator for delivering the screenings into a pocket. These machines are operated by electricity or steam. Under favorable conditions one of these machines will handle 30 cars per hour.

Unloading from vessels to cars is accomplished at the Penarth Docks of the Taft Vale Railway, England, by using four movable hydraulic coal-tips.

Figure 99 shows four hoisting or unloading towers of the New Haven at Providence, arranged to take coal from vessels to cars or storage pockets. Upward of a million tons of coal are discharged at the dock each year. Each tower is provided with two hoppers with a capacity of 10 tons each from which the coal is delivered into cars through gates.

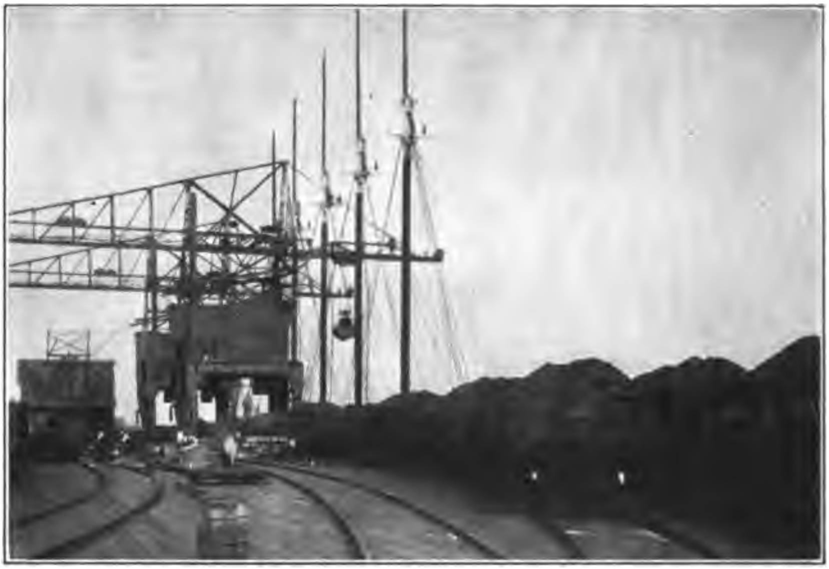


FIG. 99.—Coal discharging plant at Providence, R. I.—New York, New Haven & Hartford.

In Fig. 100 is shown a steam revolving locomotive crane unloading coal with a 2.5-yd clam-shell bucket and delivering into cars. The plant shown in Fig. 101 is a fast unloader, with tramway working independently, used by the Milwaukee Gas Company for discharging and storing coal. Each is typical of its kind.

The problem of storing anthracite coal through the dull season is an important one with the coal-mining and coal-carrying companies. The rush orders during the fall and winter tax the mines beyond their capacities and the falling off during the summer reverses conditions so that only the storage of enormous quantities of coal permits the continuous operation of the mines from one end of the year to the other. When trade is dull the coal goes to the piles and when a rush of orders comes, the piles are drawn upon to meet the demands. They also permit a policy of encouraging mining operations during summer months when coal cars would otherwise be idle. The location of a storage plant is governed by the cost of the site, conformation of the ground for the trackage necessary to the switching and disposal of cars, and accessibility to the mines, tidewater and railroad shipping facilities.

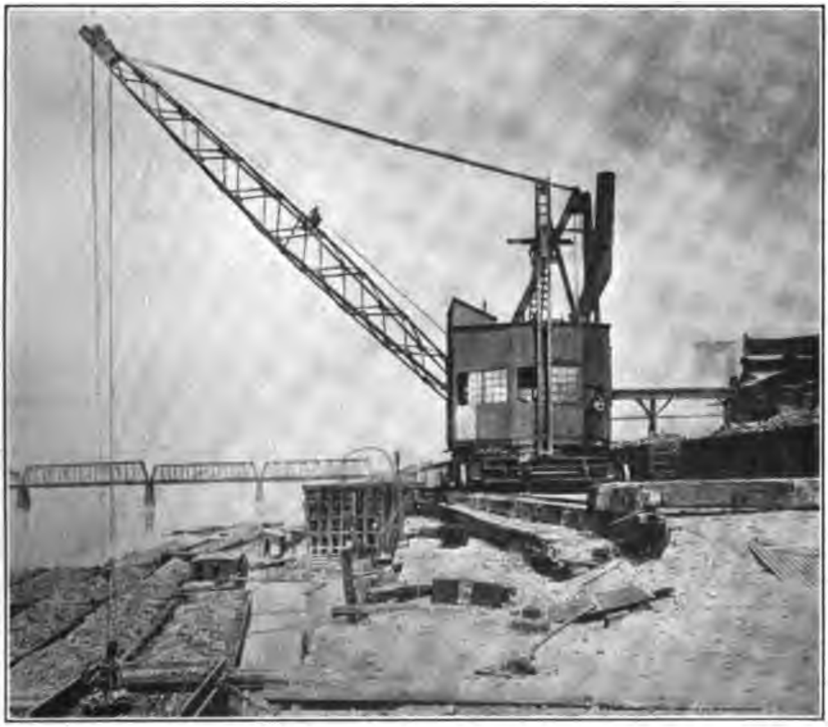


FIG. 100.—Revolving locomotive crane unloader.

One system of storing anthracite consists of two stationary trimmers, which are conveyors supported by shear trusses, for piling the coal; and a conveyor working in a tunnel between the trimmings for transferring the coal back from the piles to the cars. A series of such groups constitutes the plant of the Philadelphia & Reading at Abrams, Pa., which has a capacity of 500,000 tons. A modification of this system is that of the Lehigh Valley, at Ransom, Pa., shown in Fig. 102 in which a single trimmer does all the work. The lower end is supported on a truck traveling on a track of 10-ft. gage and the upper end on a monorail runaway which is carried on a structure supported by 16 steel columns, 83 ft. high. A 50-h. p. motor furnishes the power and may be seen in the view of the trimmer, Fig. 103. It takes current from a third rail, on the side of the trestle in which are the necessary bins. The flight conveyor carried on the trimmer is operated by a 90-h. p. motor mounted at the upper end. For unloading there are two tunnels —a longitudinal one under the trimmer and a transverse tunnel from the middle of the runway on the side away from the trimmer. Two re-loaders, one on the trimmer side and one on the other side, move on longitudinal tracks and carry coal in conveyors from the edge of the pile to the longi-

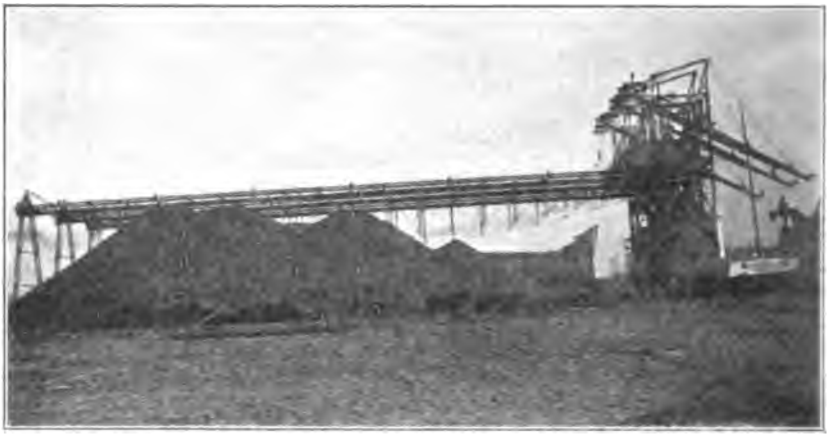


Fig. 101.—Fast unloader—Milwaukee Coal Co.

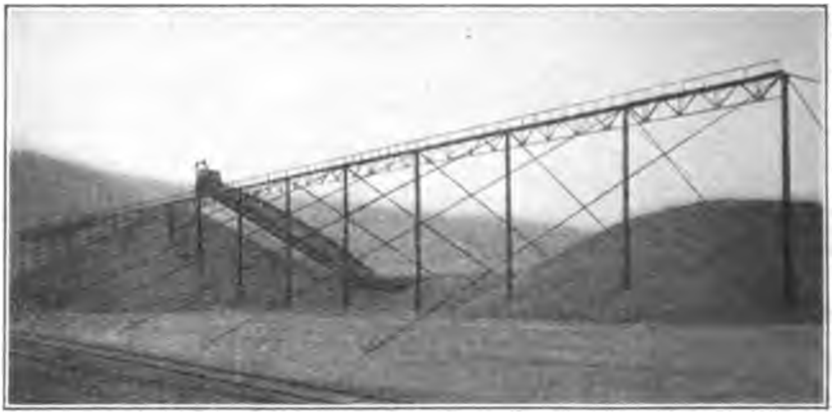


Fig. 102.—Coal storage plant, Ransom, Pa.—Lehigh Valley.

tudinal tunnel in which the flight conveyors carry the coal to the center, whence it is discharged in chutes leading to a bucket conveyor running in the transverse tunnel, by which the coal is carried to the edge of the pile and then elevated to the screen tower over the unloading tracks. The two sets of shaking screens have a capacity of 300 tons an hour. This is so rapid that it is found economical to store all sizes of coal indiscriminately instead of separating it into piles of different sizes. The power house, supplying electricity, can be seen at the right of the photograph. The manufacturers estimate the cost of installing the system at one dollar per ton of storage capacity and the cost of handling coal, both ways, from 3 to 6 cents per ton. The Ransom plant forms a pile 83 ft. high, 342 ft. wide and 1244 ft. long, with a capacity of 400,000 tons which may readily be increased.

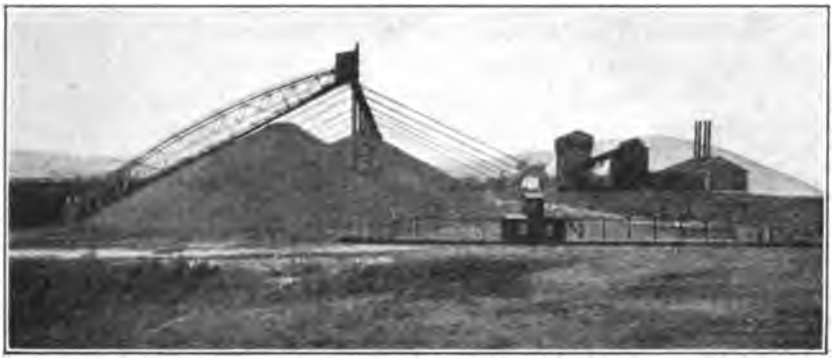


FIG. 103.—Coal storage plant, Ransom, Pa.—Lehigh Valley.

For storing coal, to hold for market requirements and to unload and reload it mechanically, the New York Central erected a plant at DeWitt which consists of a revolving steel truss 210 ft. long between supports. The inner end is carried on an elevated turntable and the outer end upon a steel frame, resting upon four-wheel steel trucks, traveling on a circular track 420 ft. in diameter, concentric with the elevated turntable. Under the turntable is a coal pit, on two sides of which coal can be discharged from hopper-bottom cars. The coal is elevated from the pit by means of a 2.5 ton clam-shell bucket, conveyed along the truss by wire rope trolley and deposited at any desired point in the storage area. The storage area has a capacity of 25,000 tons on each side of the coal delivery tracks. Coal may be delivered in and out of storage at the rate of 60 tons per hour, although on a test 120 tons per hour were handled. The average cost per ton handled is 3.5 cents, and under favorable conditions 2.7 cents.

The United States Bureau of Mines recently made a series of tests of four kinds of coal, to determine the rate of deterioration and liability of spontaneous heating in storage, which demonstrated that storage under water unquestionably preserves the heating value and physical strength of the coal, but it practically necessitates firing wet coal, and therefore means the evaporating in the furnace of an amount of moisture varying from 1 to 15 per cent., according to the kind of coal. This factor is an important drawback to storage under water, with coals like the Illinois and Wyoming types, which retain 5 per cent. or more, of water, after draining, but in case of the high-grade Eastern coals, if firemen are permitted, as is ordinarily the case, to wet down their coal before firing, then the addition during storage of the 2 or 3 per cent. of moisture which these coals retain would be of little consequence. Storage by submerging is an absolute preventive of spontaneous combustion and on that account alone its use may be justified with some coals, but merely for the sake of saving to be secured by avoidance of weathering there does not seem to be good ground for its use. The losses in coal due to spontaneous heating are much more serious and must receive more careful consideration.

With full appreciation of the fact that any or all of the following recommendations might under cetrain conditions be found impracticable, they were offered as being advisable precautions for safety in storing coal whenever their use does not involve an unreasonable expense:

1. Do not pile over 12 ft. deep nor so that any point in the interior will be over 10 ft. from an air-cooled surface.
2. If possible, store only lump.
3. Keep dust out as much as possible; therefore, reduce handling to a minimum.
4. Pile so that lump and fine are distributed as evenly as possible, not, as is often done, allowing lumps to roll down from a peak and form air passages at the bottom.
5. Rehandle and screen after 2 months.
6. Keep away external sources of heat even though moderate in degree.
7. Allow 6 weeks' "seasoning" after mining before storing.
8. Avoid alternate wetting and drying.
9. Avoid admission of air to interior of pile through interstices around foreign objects, such as timbers or irregular brickwork; also through porous bottoms such as coarse cinders.
10. Do not try to ventilate by pipes, as more harm than good is often done in this way.

CHAPTER XVIII

ORE AND LUMBER DOCKS

Methods of loading and unloading coal, ore, sand, cement and other coarse ordinary freight and discharging vessels containing it, necessarily differ as does also the machinery used to assist in such work. They vary particularly because the character and quantity of freight handled at each dock usually is of many kinds. Coal handling is described elsewhere.

Lumber is usually handled by cranes such as are described hereinafter. As water transportation is vastly more economical than rail for coarse, bulky commodities, on which time is not essential, much freight is transfered from cars to vessels, or *vice versa*, to utilize the water transportation afforded by the rivers and lakes of the United States. A vast amount is handled on the Great Lakes. In many instances the handling includes storage in addition to the transfer. Ore, coal, coke and lumber freight may be accumulated on the water front, and stored until needed, because of opportunities to purchase in favorable markets, necessity for storing quantities in advance, to care for anticipated orders for finished product and, in the case of coal, because it may be mined, screened, etc., to better advantage during summer months, and at the time when railroads have a surplus of coal cars on hand. In addition to the machinery for transferring a cargo from cars to vessels or *vice versa* it then becomes necessary to supply additional machinery and track arrangements for unloading into storage pockets or onto storage piles, and again reloading it.

A view of a successful and rapid machine for handling coke and coal in the storage yards of the Illinois Steel Company at Stockton, Ind. is shown in Fig. 104. The machine consists of system of conveyors which handle coal and coke both into and from the storage yards. All operations are performed by one self-contained unit, instead of by entirely separate systems. The machine operates on its own track. To increase the storage capacity of a yard, the only expense necessary is the cost of lengthening the machine track and the trestles from which the cars are dumped. In the Stockton yard, the machine handles material from any part of the present yard, which is 100 ft. wide and over a quarter mile long. There is room to extend the siding on which the machine runs three-quarters of a mile further if necessary. About 100,000 tons of coke are ordinarily stored. It is operated by three men and delivers the coke to the car at the rate of 3 tons per minute, at a cost of 1 cent per ton and without damaging the material.

The first cost is small and the operating expenses are comparatively low. The cost of handling material into and out of storage is less than 2 cents per ton, or about one dollar per car, which compares well with a cost of about 20 cents per ton in loading from storage by hand.

This machine has numerous applications. Different sizes are built, ranging from the mine car loader, having a capacity of 30 to 40 cu. ft. per minute, to machines running as high as 300 cu. ft. per minute. It is adapted for the use of contractors in tunnel work, as well as in mines in general. The storage machine in its different sizes will handle coal, coke, loose rock, tailings, fire-clay, gravel, sand and other loose materials, at a cost claimed to be surprisingly low.

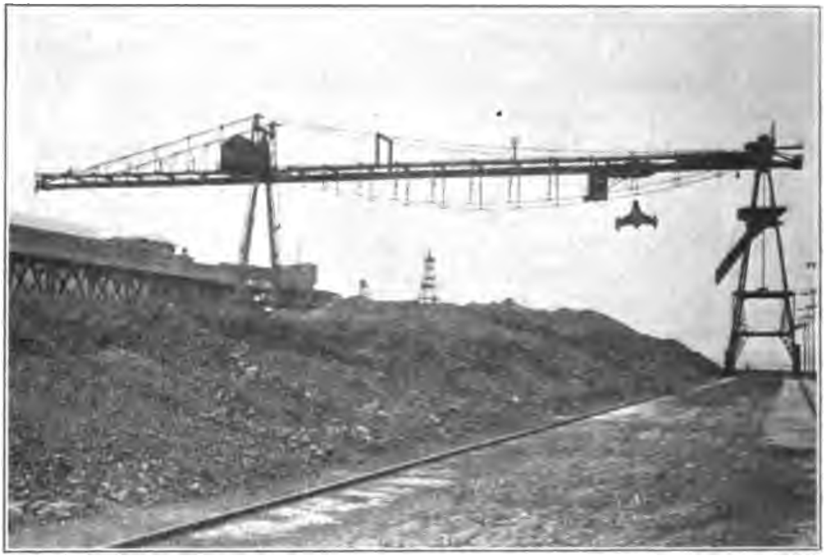


Fig. 104.—Ore handling machine, Stockton, Ind.—Illinois Steel Co.

A machine for handling sand from barges to bins, with a capacity of 90 cu. yd. per hour, running on four wheels on an independent track, with grab-bucket crane, is in use in St. Louis, by the Union Sand and Material Company and is shown in Fig 105.

Figures 106 and 107 are views of the Hulett ore unloader of the Buffalo, Rochester & Pittsburg at Buffalo; Fig. 107 shows leg of unloader in hold of boat and also shows the advantages of the modern construction of vessels, enabling them to discharge their cargoes rapidly and economically, as compared with the adapted "between decks" with numerous small hatches of the older ships.

Previous to 1903 all ships at the Buffalo terminus were unloaded by hand, making the cost high. In 1903 improvements were completed, consisting chiefly of the installation of a complete Hulett unloader plant, which has been in satisfactory operation for several years and has greatly decreased the cost of unloading iron ore.

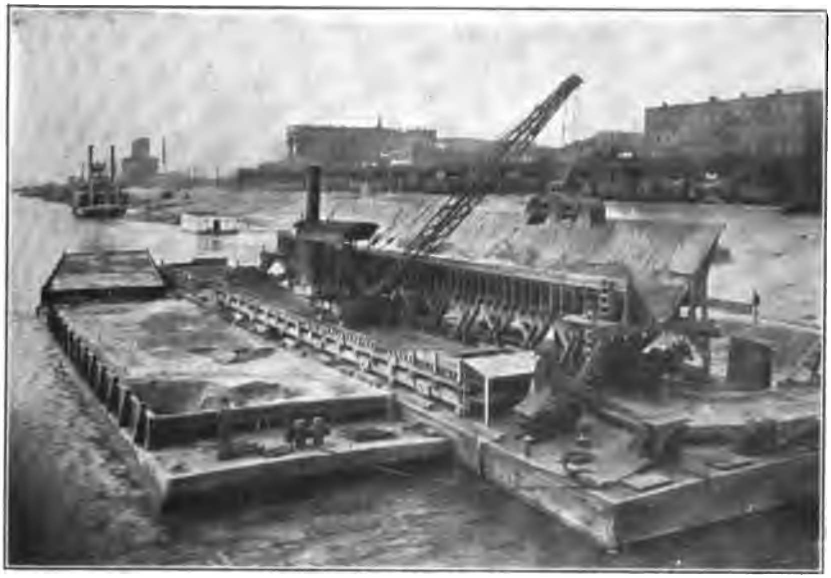


FIG. 105.—Union Sand Material Co.'s Plant, St. Louis.

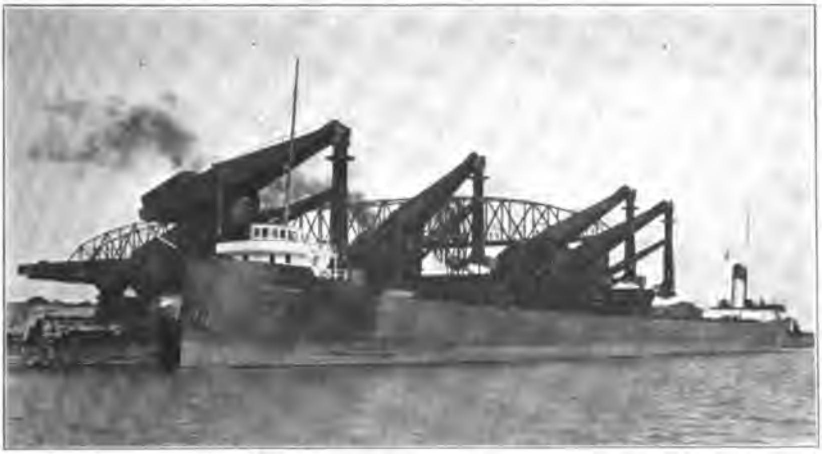


FIG. 106.—Mechanical (Hulett) unloaders at Buffalo.

The dock upon which the machine is located is comparatively short, making it necessary to use four stub tracks beneath it, as shown in the general elevation. Ore can thus be unloaded into cars on either one of these tracks, the normal capacity being about 2000 tons per day of 10 hours.

The unloader consists essentially of two parallel girders at right angles to the length of the dock, mounted on trucks. These support the trolley or carriage which in turn carries the walking beam, the outer end of which supports a vertical leg provided at the lower end with a bucket. The bucket leg is suspended in a vertical position and the operator rides in it just over the bucket, and therefore goes into the boat at each trip. From his position he can see its working and control its movements. By means of hoisting mechanism, the beam is made to oscillate up and down, carrying the bucket up over the hatch or to the bottom of the hold. When the bucket reaches the pile of ore in the boat it is closed and filled, after which the leg is raised and trolleyed back over the hopper on the dock into which the contents of the bucket are discharged. From the hopper, the ore is dumped into an auxiliary "bucket car," which in turn transfers the ore to the cars, while the bucket is returning to the hold for another load. The bucket leg is mounted on rotating trunnions in the walking beam so that the bucket can revolve and reach out in all directions beneath the hatch.

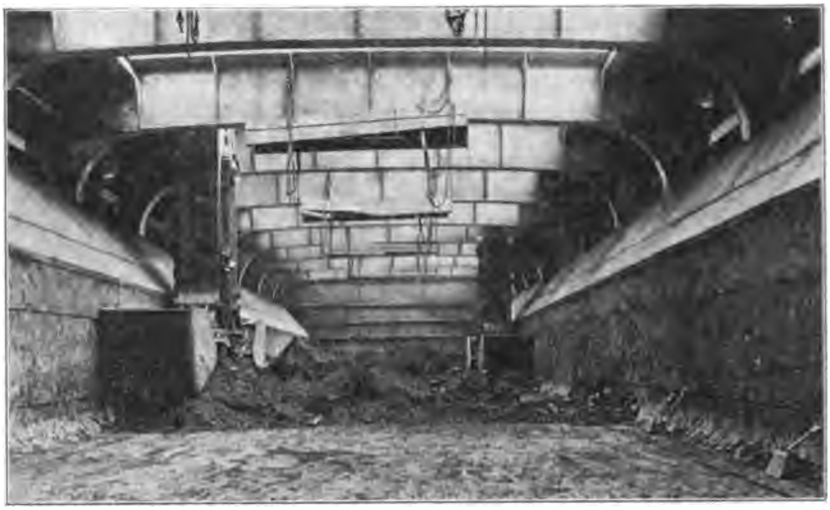


Fig. 107.—Leg of Hulett unloader in boat.

The bucket has a capacity of about 10 gross tons and a speed of 60 buckets in 40 minutes has been obtained. The usual speed is about one trip per minute and is easily maintained. The bucket has a spread of 18 ft. 3 in., with an additional scraping motion of 2 ft. 11 in., thus making it possible to reach more than halfway from the center of one hatch to the center of the next, considering 24-ft. centers of hatches. The bucket leg also travels lengthwise of the hatch so as to reach both sides of the boat. In an ordinary ore-carrying boat no difficulty is experienced in reaching 90 per cent. of the cargo, and in some of the modern boats 97 per cent. has been unloaded without the help of shovelers. The bucket operator controls all the movements of the machine except the travel from hatch to hatch and the operation of the "bucket car," which are controlled by another man.

An hydraulic pump and a steam boiler, each of 175-h. p. capacity, furnish the necessary power. Hydraulic cylinders furnish the power for hoisting, for lowering, for trolleying and for rotating the bucket. Excessive pressure on the water bottom of the boat is prevented by the use of a counter-balance cylinder. Each hydraulic cylinder has automatic plugging valves which stop its motion at the end of the stroke. An auxiliary steam engine is used for moving the machine along the dock and for operating the "bucket car."

Steamers arriving at Lorain, O. (Baltimore & Ohio), with ore are unloaded by Brown hoist machines, driven by electricity, equipped with three grab buckets, having a total capacity of 1000 tons ore per hour. These buckets scoop up from 7 to 10 tons ore each trip. The ore is dumped into hoppers for storage or directly into cars.

In loading and unloading lumber, machinery plays an inconspicuous part because the long pieces cannot ordinarily be handled by anything but ordinary derricks, after chaining around as many sticks of timber or pieces of board as may be kept together. Lumber handling vessels usually have fore and aft hatchways through which lumber is passed, but in many cases it has to be lifted vertically through deck hatchways. At some water-front docks handling large amounts of lumber, conveyors are provided to carry it to the storage points in yards or alongside tracks for transfer to open cars, and re-shipment by rail. These conveyors are usually a series of rollers, similar to those in use at the large saw-mills.

Figure 108 is of a plant consisting of 12 ore handling towers, each equipped with 2-ton clam-shell ore buckets for taking coal or ore out of vessels and delivering it into storage and later taking it out of storage and delivering into cars.

On the great lakes much progress has been made of late years in improving the type of vessels used in ore and coal carrying trade and this made it possible to use faster working loading and discharging machinery and thereby greatly to reduce the handling cost. On the Atlantic seaboard little has been done in this direction.

Steamers "James E. Davidson," 524 ft. long; "James P. Walsh," 500 ft.; and "James C. Wallace," 552 ft., operating on the Great Lakes, have a carrying capacity of 8000, 9000 and 10,000 gross tons respectively and are unloaded by clam-shell machines. They are of the new lake type.

The "E. H. Gary," built for the Steel Corporation, carries 10,000 gross tons—has carried 10,887—and is of low power. Its economy lies in the fact that it carries its load on the same fuel consumption as the "Manola," which has but 3000 tons capacity. The ore carrier has undergone many changes of design and construction. Hatches were formerly spaced 24 ft. center to center. All hatches are now spaced 12 ft. center; that is to say, it is 12 ft. from the center of one hatch to the center of the other. This leaves a deck strip of only 18 in. between hatches, and the deck is therefore almost a continuously open hole from pilot house to engine, the space between hatches being only that necessary for the transverse girders. The engines of the lake freighters are far aft. By this system vessel hatches have been practically doubled in number, thus affording greater convenience in loading and greater dispatch in unloading.

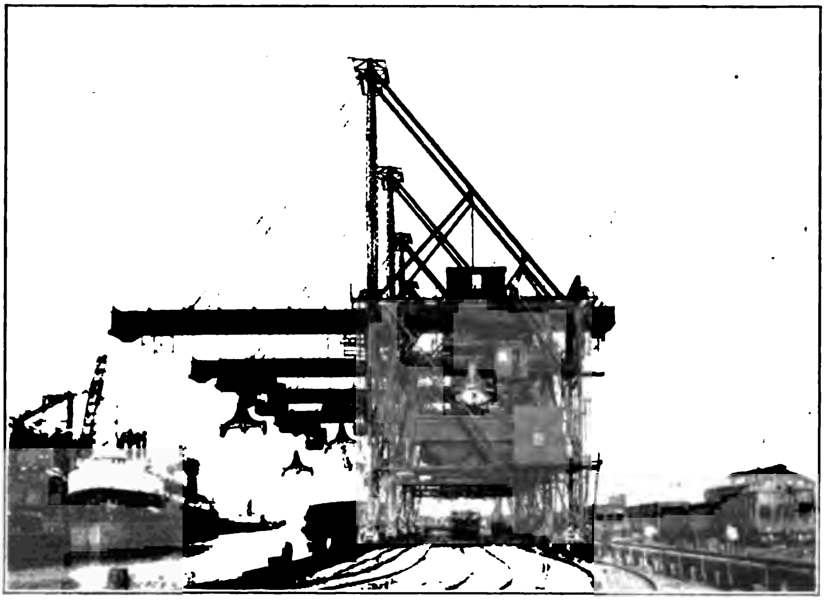


FIG. 108.—Twelve ore-handling towers in one plant.

Three years ago, longitudinal rigidity was secured by stringers and stanchions extending from the sides of the vessel. These projections interfered with the unloading machines and it became necessary to obviate them in some manner if the utmost dispatch was to be secured in unloading. Their place is now taken by a girder, straight in some ships and curved in others, extending from side to side of the ship directly between the hatches. This system leaves the hold absolutely unobstructed and is the accepted design of the lake freighter to-day. The system has marvelously facilitated the great unloading machines, the steamer "Geo. W. Perkins," with a cargo of 10,514 tons, having been unloaded in 4 hours and 10 minutes. The great unloading machines, with automatic clam-shell buckets, grab from 10 to 12 tons of ore at a time and make a trip a minute. This cargo was unloaded directly into the cars, the car moving very slowly under the machines and receiving the contents of the buckets as it went along. Four of these buckets will fill a car. The "Perkins" took on this cargo in 89 minutes, 9000 tons of it being the work of the first 35 minutes. She was in port altogether 180 minutes, which included shifting. Ships of special design, docks of special design and unloading machines of special design, all working in unison, have brought this about.

In Fig. 109 is shown the yard and dock arrangement of the Pennsylvania ore unloading piers at Cleveland, Ohio, which are now under construction. It was necessary to reclaim about forty acres of land by filling with slag and other refuse, to build a dock, foundations for ore unloaders and bridge, power-house, yard, and a double-track subway under the line of the Lake Shore and Michigan Southern.

The unloading equipment consists of four 17-ton Hulett unloaders and one 15-ton ore bridge, built and erected by the Wellman-Seaver-Morgan Company, Cleveland. The unloaders are electrically operated, using 220-volt direct current, have sufficient reach to unload boats of 65-ft. beam, and are equipped with a 70-ton receiving hopper and 50-ton larry arranged to load ore into cars standing on any one of four loading tracks or into the ore trough, from which it can be placed in stock piles by the bridge. Each machine is equipped with scales for weighing ore before loading into cars, the scales being a part of the larry car equipment. The capacities of the motors are as follows: 300 h. p. for beam hoist, 100 h. p. for trolley, 100 h. p. for bucket closing, 150 h. p. for ore gate and travel motor, 150 h. p. for larry car haulage, 35 h. p. for rotating bucket and 35 h. p. for larry gates. These machines are the largest ore unloaders ever built, and it is expected that they will handle an average of 600 tons per hour, to do which their capacity during the early stages of unloading must reach a rate of 1000 to 1200 tons per hour for each leg.

The bridge has a central span of 266 ft., with two cantilever arms 173 ft. long to the extreme position of the bucket. This provides a total length of 612 ft. In rehandling ore from the stock piles the bridge bucket discharges into a 75-ton receiving hopper built into the framework of the main tower. This hopper discharges into a scale hopper located over a loading track adjacent to the bridge foundation wall so that ore can be discharged directly from scale hopper to cars. The bridge is moved along its tracks by 75-h. p. motors connected by gearing and shafting to driving trucks under the tower and shear leg, the motors being controlled from the operators's house suspended from the main bridge tower. The bridge runs on 3-ft. gage tracks laid with 100-lb.

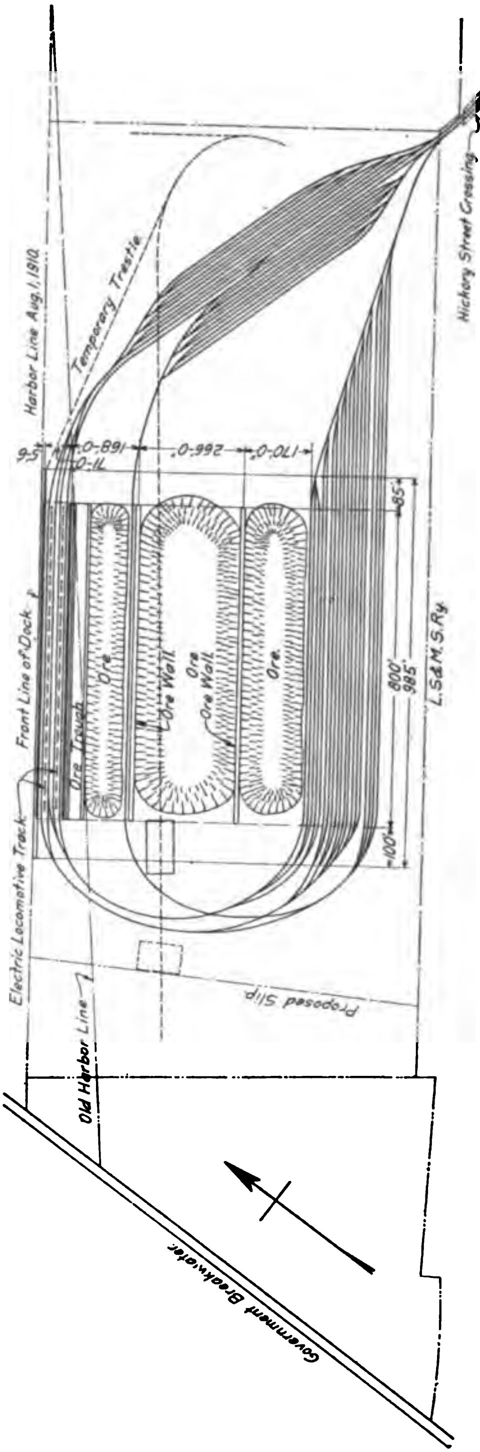


FIG. 109.—Ore docks at Cleveland, Ohio—Pennsylvania Railroad.

rails on oak ties 3 and 4 ft. long, spaced 18 in. center to center, every third tie being drift-bolted to the foundation, and all ties being connected by a 2 by 12-in. plank outside the track. Special tie plates, clips and screw spikes are used on all ties.

The power for operating the plant is secured from a power-house 150-ft. by 60-ft., located at the west end of the property, the floors and columns being of reinforced concrete, the frame of steel, and the walls of brick. Coal is received in hopper cars over a wooden trestle approach to the bunkers, which are built entirely of concrete and located outside the building. A grab bucket operating on an elevated track carries the coal from the bunkers to the crusher located over steel hoppers, through which the coal passes to the stokers. The ashes are dropped from the grates through a chute into standard gage cars running on tracks on the first floor. The equipment of the power-house includes three 600-h. p. Babcock & Wilcox Stirling boilers, equipped with Roney stokers and individual steel stacks 66 in. diameter and 125 ft. high; two Dravo & Doyle centrifugal boiler feed pumps, three Allis-Chalmers non-condensing turbine-driven jet condensers, one 2500-h. p. Cochrane water heater, one 800-k. w. Westinghouse generator, three 750-k. w. Allis-Chalmers turbo-generators, three 500-k. w. Westinghouse rotary converters, two 50-light General Electric arc lamp turbines and two 500-gallon Watson-Stillman general service pumps. Water is taken directly from the lake through a 30-in. pipe to an intake well located under the turbines. The hot well is located above the intake well, and overflow is discharged into the lake through a 30-in. pipe. Power for the machinery on the dock is carried by cable through underground ducts to the forward bridge and trough walls, along which it is distributed through 85-lb. rail supported on cast-iron brackets bolted to the walls. Electric locomotives are used for shifting cars beneath the unloaders, power being supplied by rails between the rails of the narrow-gage running track. These locomotives are of 25 tons weight, 3.5-ft. gage and are provided with side pusher arms designed to handle the standard gage cars on adjacent tracks. The spacing 18.5 ft. between outside loading tracks provides room for a narrow-gage track between each of these pairs of loading tracks, allowing the electric locomotives to reach cars standing on any track under the unloader.

A machine shop 60 ft. by 70 ft. at the west end of the property will handle repair work necessary on the ore-handling machinery, and will be provided with a 25-ton crane, the runways of which will extend across the tracks in front of the building so that repair parts can be handled direct from cars to the shop. This crane will also be used for handling the electric locomotives.

The track development is shown in the plan. Empty cars coming to the plant are stored in the yard at the east end, from which they can be switched directly to the four tracks under the unloader or to the single track along the bridge. Loaded cars are stored in the large yard south of the stock piles. This arrangement of tracks makes the movement of cars at the dock continuous.

CHAPTER XIX

GRAIN ELEVATORS

From the first preparation of the soil for wheat growing until the wheat is turned into flour, machinery plays an all important part. It may be said to begin with the use of the plow and reach its highest development in the modern grain elevator.

The enormous amount of grain handled and the growth of the traffic may be comprehended by the following statement showing the combined receipts—including wheat, corn, oats, and flour—each barrel of flour being counted as 4.5 bushels of wheat—at four principal northwestern markets, in 1887—and 20 years later:

	1887	1907	Per cent. increase
Duluth,	23,649,694 bushels	84,550,412 bushels	257.
Milwaukee,	31,960,319 bushels	58,928,462 bushels	84.
Minneapolis,	48,618,563 bushels	134,991,765 bushels	177.
Chicago,	163,437,724 bushels	307,246,141 bushels	88.

Dr. Dodlinger in his "The Story of Wheat" divides the transportation of wheat into four aspects: (1) Transportation from the farm to the local market; (2) from the local market to the primary market; (3) from the primary market to the seaboard; and (4) from the seaboard to the foreign market.

From the farm to the local market the wheat is usually hauled in wagon loads. Except on the Pacific slope, where it is sacked, the wheat is transported from the farm to its ultimate destination in bulk and its flowing quality is used to assist in its economical handling. Direct from the field or from the storage granaries on the farm the wheat is carted to the local market and from there shipped to the primary market. To take care of the wheat at the local market and facilitate its transfer from wagon to car, the grain elevator performs the useful functions of storage, cleaning and drying. The wheat flows from the wagon into receptacles at the elevator from whence it is lifted by power driven buckets to the storage bins. From these bins it flows into the cars or into the drying and cleaning apartments as may be desired, or is held indefinitely up to the capacity of the elevator. At the local markets there are many small elevators, ranging from a capacity of 10,000 to 40,000 bushels. Most of them are owned by elevator companies; others belong to local grain dealers; the remainder belong to the farmers. On the Northern Pacific, a few years ago there were upward of 800 elevators of which 58 per cent., belonged to the line elevator companies; 39 per cent. to the local grain dealers; and 3 per cent. to the farmers.

It is at the primary market that the grain elevator assumes its greatest importance. At 25 large terminal markets or exporting points in the United States there are 428 elevators with an aggregate capacity of 260,541,000 bushels. These points, with the number of elevators they have and their approximate capacity in bushels, are as follows:[1]

	No. of elevators	Capacity, in bushels
Chicago,	87	58,945,000
Minneapolis,	48	40,890,000
Duluth,	23	30,175,000
Buffalo,	28	24,190,000
Milwaukee,	21	13,960,000
New York,	18	13,230,000
St. Louis,	39	12,080,000
Kansas City,	38	11,290,000
Toledo,	10	6,250,000
Omaha,	15	6,040,000
New Orleans,	9	5,180,000
Baltimore,	5	5,100,000
Detroit,	14	4,540,000
Montreal,	10	4,150,000
Galveston,	4	3,800,000
Philadelphia,	4	3,100,000
Louisville,	7	3,000,000
Boston,	4	3,000,000
Newport News,	2	2,550,000
Cincinnati,	12	2,010,000
Indianapolis	9	1,955,000
Cleveland,	6	1,916,000
Nashville,	5	1,700,000
Seattle,	2	1,550,000
Evansville,	8	740,000

In these great storehouses the grain is gathered and loaded into cars or vessels for shipment to seaboard. Some of them will hold a million and a half bushels; and, again, at the seaboard the elevators play their important part in transferring the grain from car to ocean steamer. The largest elevator has a capacity of 1,800,000 bushels

It may be of interest to sketch briefly the successive steps taken by the grain in its movement from car to ocean steamer at a seaboard grain elevator. When unloaded from the cars into the receiving hoppers of the elevator it is carried upward to one of the series of weighing bins. Here the weight of each car is ascertained and recorded. The bin is a scale unto itself and is carefully adjusted before the contents of the car begin to flow into it. From the weighing bin the grain flows to storage bins where it is held subject to the orders of the owner. Possibly it may need cleaning or drying, or the agents may desire to mix it with a better or poorer grade. In either case, the grain flows from the storage bin to the dryer, the cleaner, or is mixed with other grain as desired, and again elevated to a storage bin to be held until orders are given to load it into a steamer. Then from the storage bin it flows either directly through spouts to the open hatch of the vessel or is transferred by belts through galleries along the pier until it reaches a loading spout through which it finds its way into the hold of the boat.

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[1] **This statement and other following information on grain handling are taken from an article by S. O. Dunn (Ry. Age Gaz., 46; 1171).**

As already stated, the farmers on the Pacific Coast adhere to the older European practice of loading the grain in sacks instead of taking advantage of the flowing properties of the grain which allows it to be so readily handled in bulk. One reason is that the well-defined limits of the rainy season on the Pacific slope make it unnecessary to provide protection against rain in the dry season, and the wheat may be stored in sacks on platforms, a practice which could not be followed east of the Rockies. Thus the problem of storage capacity is made easier, but on the other hand the sacking method is plainly uneconomical.

The loading of a 1000-bushel car of sacked grain at the country warehouse takes two men 2 hours, while it can be loaded in bulk by one man in 5 minutes. The railway freight on bulk grain is the same as on sacked grain; in other words, the transportation of the sack has to be paid for at the same rate as the transportation of the grain. At tidewater it takes 12 men, including the weigher, 1 hour to unload and pile a car of 1000 bushels in sacks. In bulk three men can sweep out a car, unload the grain and bin it in from 5 to 10 minutes. It takes 15 men 4.5 days of 8 hours each to load a vessel with 125,000 bushels of sacked grain. In bulk the same quantity of grain can be loaded in 3 or 4 hours by one-half as many men.

The presence of elevators on its lines is advantageous to a railway. Grain can be accumulated in the elevator until there are several carloads and then poured rapidly into the cars. Thus, the delay to rolling stock is less than when the grain is shoveled from the farmers' wagons into cars or transferred direct from the farmers wagons to the cars in sacks. There was a time when there were a number of little flat warehouses along the railways in the Middle West, some of them having a capacity as small as 1000 bushels. It took 2 to 4 days to scoop enough grain from one of these to load a car. On the other hand, the ordinary country elevator had a capacity of several thousand bushels. A modern country elevator usually has a capacity of not less than 25,000 bushels; and 10 to 15 cars can be loaded from it daily. Where sack grain is accumulated in flat warehouses before being loaded on cars, the delay to railway equipment in loading is less than the delay that would be caused by shoveling it from a wagon into a car, but it is substantially greater than the time taken to load cars from an elevator. In seasons of heavy railway traffic the elevators afford a place where large quantities of grain can be stored awaiting cars. The elevator system, therefore, tends at such times to reduce the congestion of traffic.

The foregoing relates mainly to the country elevators. The advantages to the farmer, the shipper and the railway, of terminal elevators at large markets were early recognized to be equally great. The grain as it came from the farmer often needed to be dried, cleaned, or graded, to render it fit for export or for milling. In Illinois, for example, during a wet season, there is occasionally a soft corn crop. In this condition it cannot be transported far without spoiling, and it is necessary to get it to a point where it can be properly treated. This usually can only be done in a large terminal elevator, as the country elevators are seldom equipped with machinery for any purpose but the elevation and loading of grain. The existence of facilities for treating the grain so as to keep it from spoiling, inures in the long run to the advantage of producer, carrier, grain dealer, and consumer.

Usually, when grain is bought, its ultimate destination is unknown; it may be ground into flour in Minneapolis, or St. Louis, or Chicago, or shipped to the Atlantic seaboard, or sent to Europe. The merchant, therefore, needed a place to keep it while seeking a buyer. The terminal elevator serves this purpose. It is often advantageous to mix a lower grade of grain with a higher grade in order to increase the value of the former, and the elevator usually is equipped with machinery for this purpose also.

The establishment of terminal elevators on its lines at the large markets is extremely desirable for the railway. When a terminal elevator is built on the lines of one road, the grain moving to that elevator is pretty sure to move over that road, thus insuring the traffic to that road. Much of the grain begins movement before its ultimate destination is known, and it is pretty sure to be held in storage somewhere. If not held in storage in a terminal warehouse, it must be held in cars; with consequent misuse of such cars, since their function is to move, not to store grain or other commodities. A great deal of grain has to be transferred at terminals from cars of one railway to cars of another, or to boats on rivers, canals, the Great Lakes and the ocean; and these transfers, of course, may be accomplished through an elevator with least delay to the cars. Both the country elevator and the terminal elevator enable the railroads to load their cars to their cubic capacity with the lighter grains, such as oats, which cannot be done when grain is shoveled into the car or stowed in it in bags.

The whole question of grain handling may undergo a radical change.

According to such eminent authorities as James J. Hill and W. C. Brown, this country will, in a few years, not produce enough grain to supply its own consumption, unless our farming methods are intensified, and the average yield per acre more nearly approximates that of European countries where nearly double the amount of grain is harvested to the acre. In an address before the New England Railroad Club, not long ago, President W. C. Brown of the New York Central expressed the opinion that by 1920, we would be importing grain for home consumption and, based on this assumption, his road had deferred the building of new elevators for grain handling at Buffalo.

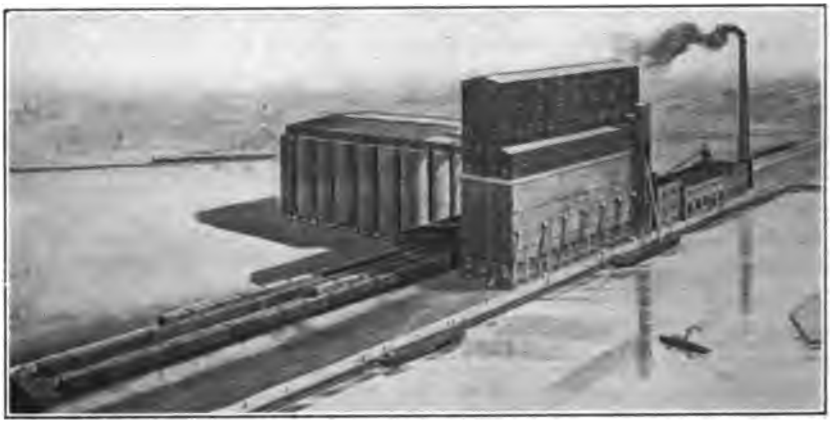


Fig. 110.—Grain Elevator at Chicago.—Santa Fe Road.

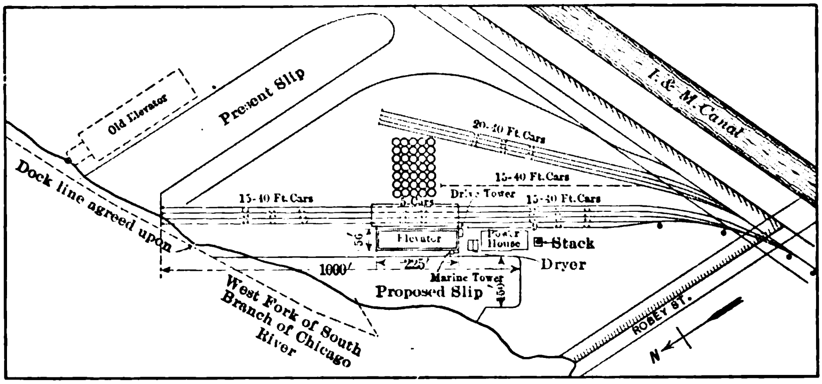


Fig. 111.—General plan, Grain elevator at Chicago—Santa Fe Road.

As an illustration of a modern and capacious elevator, that of the Sante Fe in Chicago is typical. A general view is shown in Fig. 110, a plan in Fig. 111, and a section of working house in Fig. 112.

The elevator comprises a frame working house of 400,000 bushels capacity, with car shed and marine tower; a reinforced concrete storage annex of 1,000,000 bushels capacity; drying and bleaching equipment and a 1500-h. p. plant. The working house is 225 ft. long and 56 ft. wide, of timber and cribbed construction, covered on the outside up to the top of the bins with brick and above that point with corrugated steel.

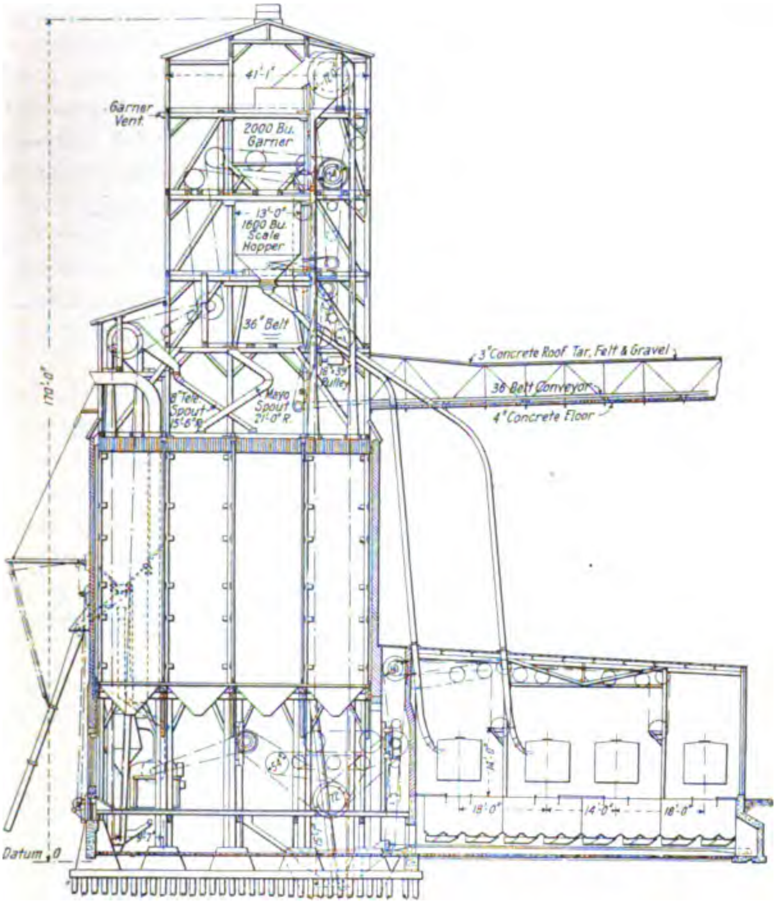


FIG. 112.—Section of working house, elevator, Chicago—Santa Fe.

The receiving and shipping legs are of unusually large capacity, namely, 15,000 bushels per hour each. There are five shipping legs and five receiving legs. In addition to these there are 15 smaller legs for serving the cleaning, scouring, drying, and bleaching plants, also one leg for disposal of screenings.

In the cupola there are 10 hopper scales, each of 1600 bushels capacity. A dust collecting system, a large car puller, longitudinal conveyor in the cupola for conveying grain lengthwise of the house, passenger elevator, etc., are essential portions of the equipment. A marine tower constructed of steel, with 6000 bushel marine leg, is at one end of the building and eight vessel loading spouts above the dock. The storage annex consists of 35 cylindrical concrete bins, each 23 ft. inside diameter; and 24 interspace bins, with 15,000 bushel conveyors for filling and emptying. The drying plant has an hourly capacity of 1000 to 1500 bushels.

The facilities provided for unloading cars form the distinctive operating feature of the working house. A steel shed extends over four tracks between the working house and the storage annex. On each track are five unloading places, located 45 ft. centers, in order to accommodate the longest cars. By this arrangement 20 cars can be set for unloading at one time. Beneath each unloading place is a steel track hopper with a capacity of a full car load. Each hopper discharges through four openings to a 15,000 bushel conveyor running below a line of four hoppers, across the basement under the track shed, to one of the receiving legs. The valves in the bottoms of each line of four track hoppers are controlled by an interlocking device under the control of the operator near the corresponding receiving leg.

The tracks are elevated to allow sufficient capacity in the hoppers and are carried on an embankment to a point 600 ft. beyond the elevator, making room for fifteen 40-ft. cars on each track outside of the track shed; and five cars on each track inside. This is a total of 80 cars which can be set at one time; 20 can be unloaded and pulled out of the track shed by the car puller and the next 20 pulled in, repeating for lots of 20 cars each, before further switching is required. After being pulled out by the car puller, empty cars will run down a gravity track to the place desired.

An elevator, of reinforced concrete construction, built for the Baltimore & Ohio in Baltimore, is shown in Fig. 113. No wood was used in its construction. Its capacity is 250,000 bushels, divided into 130 bins, varying in size from 1000 to 3000 bushels. Most of the bins are of the smaller capacity. They are rectangular in shape, the reinforced concrete walls varying in thickness from 6 in. to 8 in.

The Baltimore & Ohio unloads the cars, elevates the grain, weighs it and deposits it in bins. These bins are leased to numerous local dealers in Baltimore, and when the grain is in the bins it may be taken therefrom at the will of the lessee dealers.

For receiving, there are two tracks, each having two unloading pits of car-load size. The grain is unloaded by power shovels and then the operator pulls a lever opening a gate, which allows the grain to be discharged onto a 30-in. rubber-belt conveyor, below the car pits, and the conveyor belts transfer the grain to the bottom of the elevator legs, which lift it to the top of the cupola. From the head of the legs it is discharged into the garner and held until the weighman is ready. At the proper time he pulls a slide and allows the grain to drop into the scales from the garner. There are two hopper scales, each of 1000 bushels capacity, with printing attachment on recording beams.

After the grain is weighed it is discharged into any one of the bins directly from the scales, through spouts. Underneath the bins are two stories, the upper one being the sacking floor, where the grain is drawn off from the bins and sacked by eight 3-bushel Richardson automatic bagging scales. These scales are arranged in a row on steel tracks which run under the bins. The use of automatic scales enables the operator to bag seven bags, of 3 bushels each, every minute.

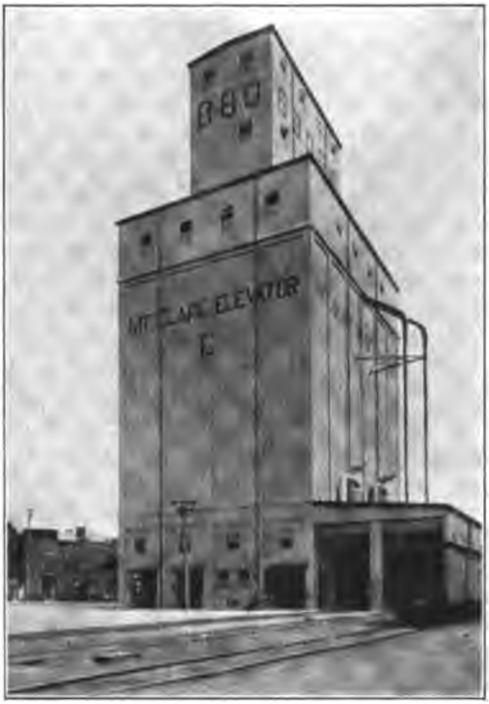


FIG. 113.—Grain elevator in Baltimore—Baltimore & Ohio.

On the sacking floor there are three 24-in. belt bag conveyors for carrying the sacks across the building and discharging to the teams underneath. There are three driveways under the elevator and one alongside under an awning, to accommodate teams.

The readiness with which grain (a low-class commodity permitting slow movement) adapts itself to water transportation may be comprehended by the statement that the steamer "L. S. De Graff" has taken from Chicago in one trip 421,000 bushels wheat, weighing 12,661 tons.

An unusually large elevator has recently been erected by the Canadian Pacific at Victoria Harbor, on Georgian Bay, for unloading grain boats from the head of Lake Superior. The company already had ample elevator capacity at the upper lake ports for transferring to boats the grain shipped down from western Canada, but there was a lack of facilities for storing and trans-shipping it at the eastern end of the lake haul The new elevator cost $1,100,000, including a concrete wharf—800 ft. long—which was carried down to provide for a 25-ft. depth of water.

Grain boats are unloaded by two marine towers, 150 ft. high, built of structural steel and covered with corrugated iron. These towers are supported on 40 wheels each, the wheels being arranged in standard freight trucks, and each is self-propelled independently along the double track which parallels the wharf. This movement is obtained by housing sufficient motor equipment in the base of the tower to operate a large drum winding up a cable which is passed out of the tower, around a fixed block and back to a fixed connection on the tower, allowing both towers to work to full capacity regardless of hatch spacing or hold capacities of incoming boats. The marines legs are designed to enter passenger and freight boats. The towers can elevate 20,000 bushels an hour. The grain unloaded may be stored or reshipped in cars. The storage capacity of the elevator is 2,000,000 bushels, but may be increased to 10,000,000 bushels. There are 32 storage tanks, cylindrical in shape, 35 ft, inside diameter, built of reinforced concrete, and 31 interspace bins, each with about one-fourth the capacity of the cylindrical bins. All bins have hoppered bottoms and are thus self-emptying. When cars are to be loaded direct from the boats, grain is handled from the unloading towers, on conveying machinery above the storage bins to the working house into which cars to be loaded can be run direct.

The electric power for the operation of the entire plant is furnished by two 500-k. w. turbo-generators in the power plant. All conveying and hoisting apparatus is motor operated. The electric wiring is carried in metal conduits and the building is fireproof in every respect. Seven hundred and fifty incandescent electric lights and twelve arc lamps are provided for night work and there are also telephones, electric signal light and bell systems and dust collectors.

CHAPTER XX

FREIGHT HOUSES

Aside from the terminal proper, there is no better opportunity for saving time than at the loading, unloading and transferring points. Freight houses and dray yards should be so designed as not only to enable quick movement between them and the classification yards, but to permit of prompt shifting and placing. The arrangement must provide for shifting with a minimum of interference with freight handlers and truck men.

Handling package—l.c.l.—freight at terminals is a complicated problem. After the work of transporting it from one point to another has been performed, the heaviest part of the expense remains. The awkward method of handling freight of many years ago, still obtains. At the freight-house it often has to be trucked 500 to 1500 ft. The cost of handling a ton of freight a mile in a train has been closely figured. Nobody knows how much it costs a ton-mile to truck freight and do the additional handling at the freight-house.

The cost of gathering and distributing freight in a large city is enormous. Economic conditions in this country have carried wages to higher and higher levels and at the same time, human efficiency to perform physical work without the aid of machinery, has diminished. The cost of all work largely dependent on manual labor has increased in the last 20 years so much that every business man is constantly seeking some kind of labor-saving device or other means of economy to stem the tide.

Mr. Charles Whiting Baker, in the "Engineering News," March 3, 1910, interestingly analyzes the relations of terminal cost to road movement and sets up two startling propositions:

> 1. That the total cost of moving freight from its origin in one city to its destination in another is *the same* for all distances less than 100 miles.
>
> 2. That the cost of terminal handling in cities is so great compared with the cost of moving a train or a vessel, when started on its journey, that the latter can be ignored.

While acknowledging at the outset that his propositions are exaggerations he goes on to prove that they are not so greatly exaggerated as one might consider on first thought. He follows a ton of freight from Philadelphia to New York. At the originating end it is loaded onto a wagon: the labor cost is 25 cents to which is added the drayage to the freight station and unloading, 50 cents. He estimates the cost of getting it onto the car and storing it, at 40 cents—including the placing on a hand truck, a long truck haul on the platform, loading into car, weighing, billing and other clerical labor. The yard engine pulls the car out of the freight-house and after many and devious movements it finally lands in the road train for New York. Adding the cost and the value of land occupied by switching yards and freight-houses and the value of buildings and other improvements, the company expends from $2 to $5 per car—— or 10 cent to 50 cents per ton—say 25 cents on the average from the time the car is loaded until it starts on its journey. Passing to the other (the New York) end, he takes the figures published by Mr. Wm. J. Wilgus—formerly vice-president of the New York Central, of $2.25 per ton, divided as follows: Jersey City terminal costs 15 cents, lighterage 80 cents, water-front terminal costs, Manhattan Island, 50 cents, New York City cartage expense 80 cents. This makes the terminal cost, for both ends, $3.65 per ton. Assuming the open road cost at 3 mills per ton-mile, the total for 90 miles' haul is 27 cents; therefore, Mr. Baker sums up: "The cost of getting a ton of freight started on its journey at one end—Philadelphia—and handling it from the Jersey City terminal to the consignee's store at the other end—New York—is *nearly fourteen times* as much as it costs to haul the goods all the way from Philadelphia to New York."

In the location of freight-houses and team yards, careful consideration should be given to the condition and gradient of the highway or street approaches. It is estimated that the cost of moving freight on ordinary roads by teams is over 25 cents per ton-mile. The necessity for keeping the shipper's side in mind is apparent. The term "shipper" here and elsewhere is used in a broad sense, including both consignor and consignee. It may be found necessary or advantageous, later on, for the railway to undertake the cartage, for reasons given elsewhere.

Where the amount of freight handled is sufficient to justify it, separate houses for inbound and outbound freight are desirable. When these are provided the outbound house should be narrow, 25 or 30 ft. in width, to shorten the truck haul from the team delivery to the car door. To increase the car capacity it will be wiser to put in more tracks alongside, and these should be spaced to permit trucking platforms 6 to 8 ft. wide to be built between each two tracks. The use of these trucking platforms renders "spotting" of doors unnecessary and obviates the straight line trucking through several rows of cars by which the truckers are at all times liable to meet, causing confusion and delay. In the process of spotting cars exactly opposite the doors a large amount of expensive switching is done, while holding up the work of transferring and causing a force of men to be idle for a time. When the cars are taken out the same process is repeated, as the cars must be recoupled. There is also more liability of injuring freight handlers than with the "island" platforms. In standardizing freight equipment cars of uniform length. begin to predominate. This reduces the necessity for "spotting" and if the good work continues, the necessity for "island" platforms will decrease if not disappear. A saving in ground area will also result with the omission of the "island" platform. A platform used for transfer purposes solely, should be from 14 to 16 ft. wide, roofed and with a track on each side.

Freight-houses should be provided with scales at frequent intervals, say 50 or 100 ft. apart, and a ranged along the side where freight delivery is made. With the increasing interest in the weighing question, it will not be amiss to locate scales, in busy outbound houses, at each receiving door. The beams should be parallel with and against the wall, leaving no obstruction to trucking.

If a separate house is built for inbound business it should be wider than the outbound freight-house so as to unload cars, release them and hold the freight for delivery. The inbound and outbound freight-houses should be located with reference to each other so that the empty cars may be quickly moved to the outbound houses for reloading. In some instances the two houses may be adjoining, and cars emptied at the one may be reloaded at the other without movement.

Freight-houses usually have a track along one side and a driveway on the other, although more tracks are sometimes worked. The writer knows of instances where four tracks alongside each other, without platforms between, were handled in a fairly economical and prompt manner. The cars have to be "spotted," however, to bring the doors opposite each other.

There are many desiderata in the construction of freight-houses, in the matter of general plan as well as details. The size and shape of the available property and the land values usually influence the results. The in-and-out house lay-out requires more track space and less storage area, but greatly facilitates prompt handling. For a heavy city business, the separate houses with a transfer between, form the ideal plant. When the business outgrows this arrangement and additional houses are needed, the operating man's real troubles begin. It then becomes necessary to establish a transfer service between each inbound and each outbound house to get that freight going beyond the station, to the proper outbound house for reloading. Ordinarily, a car is placed at each inbound house, to move this freight daily or oftener, but in some cases teams or motor cars perform this service. This condition is met in the exceptionally large and complicated freight layouts of the New Haven and Boston & Maine roads in Boston described elsewhere.

Tracks should not be run inside buildings where possible to avoid it as they cut up the floor space and necessitate higher roof trusses. Houses too wide entail unnecessary trucking; and again, if too long, require too great a train length, which either stops house work while the set-up is changed, or detains cars. Freight-houses have been built 2000 ft. long, but they are usually failures in practical working, unless the track layout is so planned as to enable part of it to be worked without disturbing the remainder.

The arrangement of continuous doors on the track side of each house is essential to avoid "spotting" cars; and supporting posts should be set back from 4 ft. to 8 ft. to prevent obstructing car doors. The receiving side of the outbound house should also have continuous doors. The standardization of freight cars, bringing about a car of uniform length, simplifies the work of "setting up" houses and platforms. To enable refrigerator car doors to be opened, track centers should not be less than 12 ft., because these doors open outward and measure from 2 ft. 2 in. to 2 ft. 10 in. in width. A slight incline of the floor in the outbound house descending from team to track side; and in the inbound house from track to team side, greatly facilitates trucking. A drop of one in sixty, adopted for some houses, has been found satisfactory.

Jambs of doors should be protected for 3 or 4 ft. above the floor by oak boards, or metal, to prevent damage by truckers. Cast-iron plates, or angle irons are used at corners. Conductors for rain water should also be protected. Platforms, if used, should have angle irons facing on the team side, especially opposite doors. Wheel guards, to prevent wagons jamming against platforms, are desirable.

The chapter on freight-house operation contains frequent references to other details of freight-house design as they relate to operation. They will not be duplicated in this chapter, which is devoted mainly to descriptions of typical freight terminals.

The Pennsylvania has seven freight-houses in Pittsburg—four of them outbound. In Philadelphia it has 31, at 28 of which freight is received for all points. In New York, the Pennsylvania has four; the New York Central eight; and each receives at four points in Brooklyn. In Boston, the New Haven has 12 freight-houses, seven inbound and five outbound–the Boston & Maine has 50, of which about half are inbound.

The Pennsylvania has two-story houses in Pittsburg. The Pittsburg & Lake Erie has a two-story house in Pittsburg, with a driveway to each floor and the Wabash house has four stories with tracks on fourth floor and hydraulic elevators connecting all floors with the street. The Reading, in Philadelphia, has two stories. The Baltimore & Ohio Southwestern in Cincinnati, has six stories and electric elevators and the Central of N. J., has a similar house equipment at Newark. The Louisville & Nashville's Atlanta, Ga., house is five stories, with eight elevators and has large areas for rent to merchants.

An interesting, novel and ingenious scheme to utilize a small and valuable piece of land on 135th Street, New York, for a combination

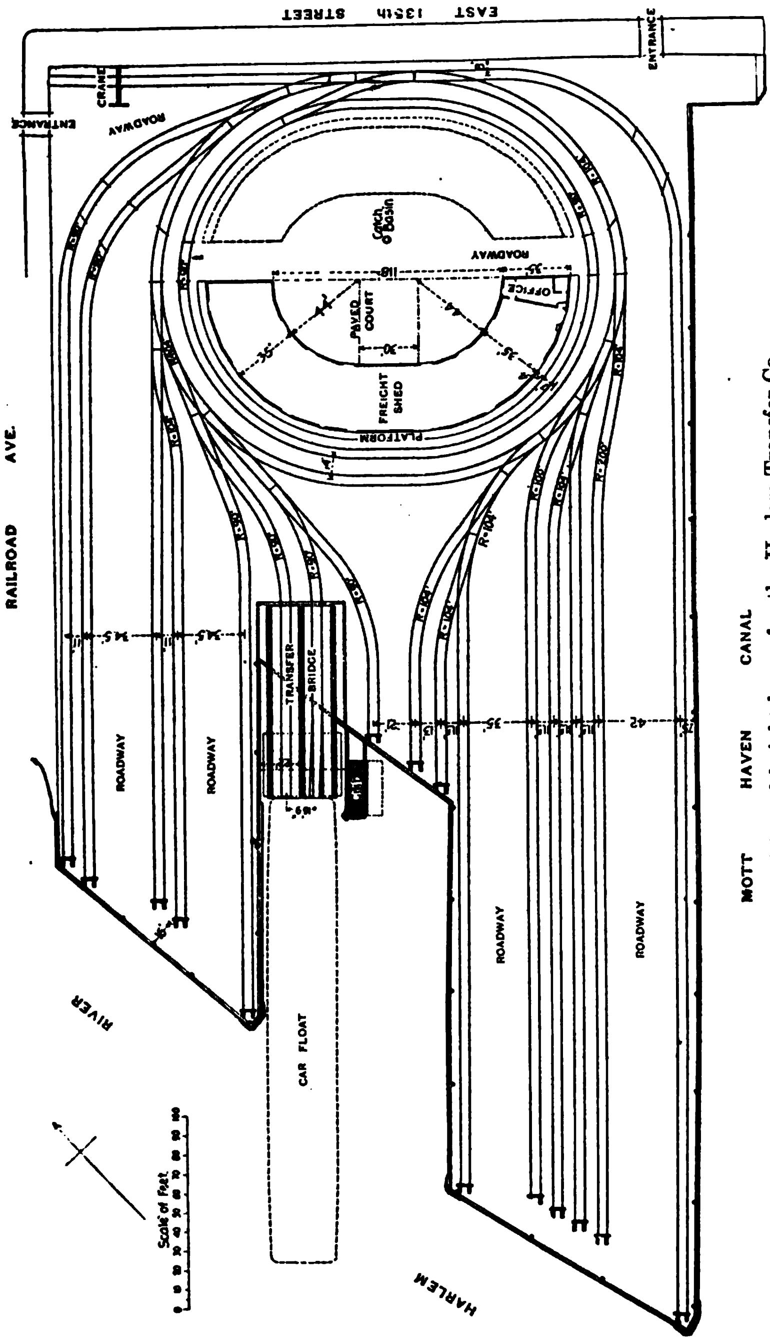


FIG. 114.—Plan of freight-house for the Harlem Transfer Co.

team yard, freight-house and platform and float bridge, was designed by the late Walter G. Berg for the Harlem Transfer Co. and is shown in Fig. 114. At this house all cars are taken in and out of floats and pass over the float bridge. The freight-house is a hollow oval 158 ft. × 188 ft., the building being 35 ft. wide. The court in the center is paved and used for teams which deliver their freight at doors 20 ft. apart in the inner wall of the building. The doors on the track wall are 40 ft. apart and the building gives a total frontage for 16 cars. A 4-ft. platform extends around the outer side and the center of the circular house track is 7 ft. from the platform. This track has end curves of 90 ft. radius. Concentric with it is the main switching track, with end curves of 104 ft. radius and having a single switch connection with the house track. These are laid to 14-ft. centers. Other curves of 90- and 104-ft. radius connect the outer track with the transfer bridge and storage tracks.

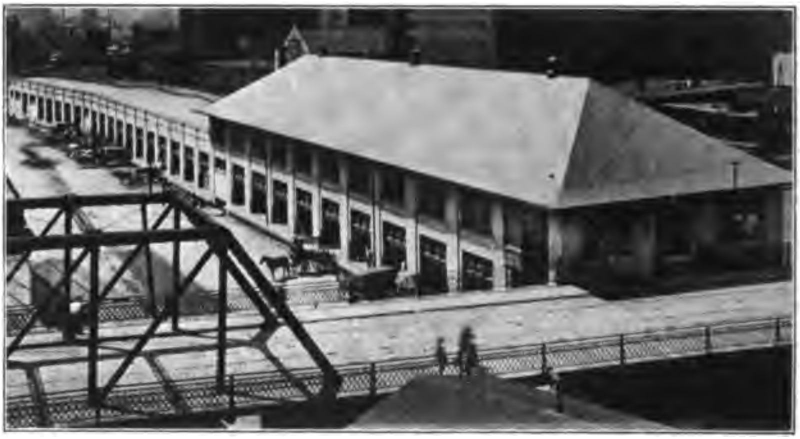


Fig. 115.—Inbound freight-house, Chicago—Baltimore & Ohio.

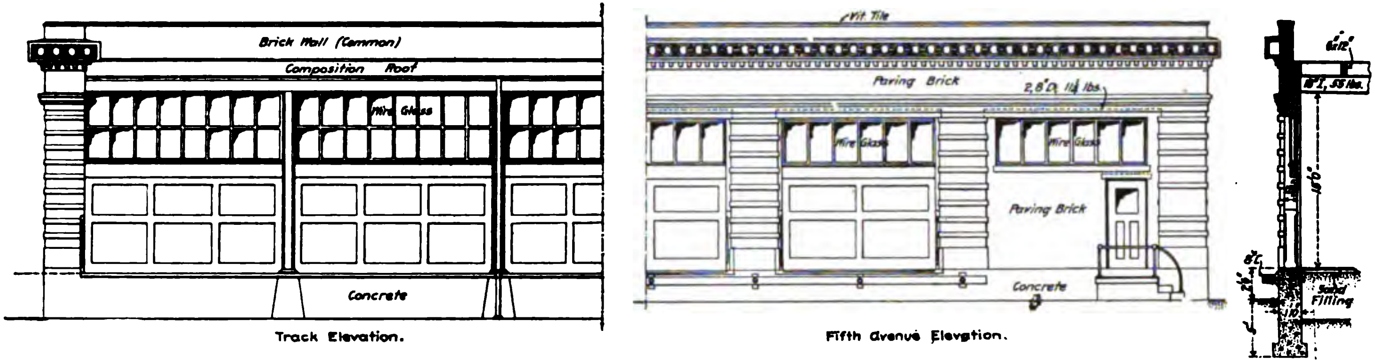
Because of the sharp curves a four-wheel "dummy" switch engine is used; cylinders 17 in. × 24 in., wheels 3 ft. 8 in. diameter, wheel base 6 ft. 6 in., total length 27 ft., weight 45 tons. Long links are provided for coupling cars on the sharp curves and no difficulty is found in handling them. This engine hauled 11 cars, some loaded, around the curve of 104-ft. radius. The work has been satisfactorily handled.

The Baltimore & Ohio inbound freight-house in Chicago, as shown in Fig. 115, while not the largest freight-house in the city, is in many respects one of the most convenient. It is on Polk Street, close to the Chicago river, and extends parallel to the river.

Including the platform at the south end, the total length is 670 ft. For 400 ft. of its length the building is 51 ft. wide. The last 170 ft. of the west wall is carried easterly in conformity with the river bank, the width at the south end being 24 ft. 2 in. The north end for 200 ft. is two stories high, the second story being for the offices of the freight department. Detailed sectional views elevations and plans are shown in Figs. 116, 117, 118 and 119.

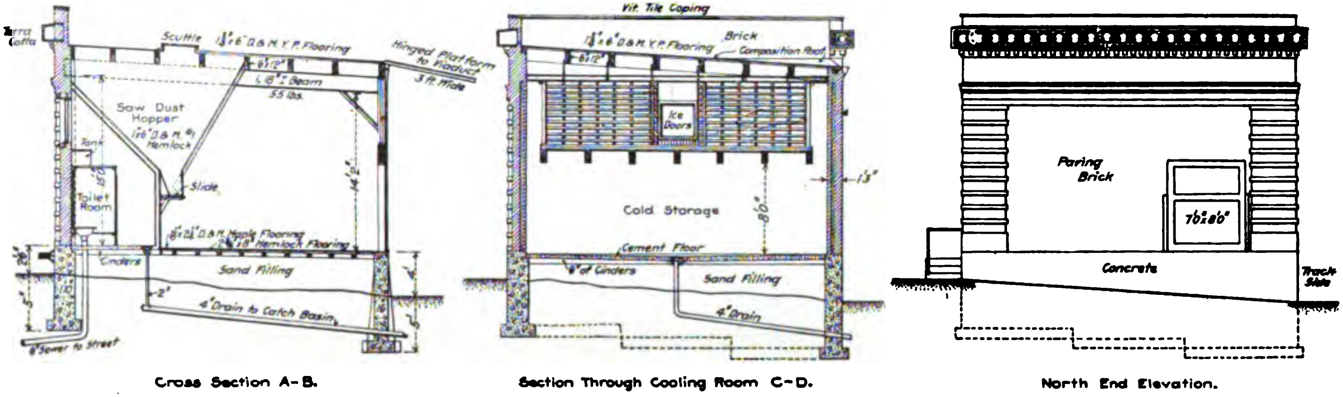
The general freight room is divided into two parts by the south wall of the two-story part. One of the conveniences of the house is the location of the offices at the north end of the general freight room, making it unnecessary to go to the general office upstairs to transact detail business. At one of these offices, teamsters may pay their freight charges and receive their delivery tickets, while at another bills for transfer freight are handled. The dead room at the northwest corner has slat walls so that its contents can be readily seen at any time. The vault is 11 ft. 6 in. × 15 ft. 6 in. with cement floor and it extends into the second story. At the south end of the house is the bonded warehouse with office for the government officer. This office is elevated so as to allow the use of all of the floor space. The room is enclosed with brick walls and is nearly fireproof. The distribution of the freight on the floor of the general freight room is such as to leave an aisle on each side, instead of through the center. This avoids any chance of the freight piling up against the walls and hiding pieces, causing loss of time in looking for them. The general offices occupy all of the second floor except 52 ft. at the south end which is used for a record room. These offices are light and have room for double the force that will occupy them at the outset. They are entered directly from the Polk Street viaduct which crosses the railroad yards; and also by stairways from the first floor. The agent's office, at the northeast corner has a bay window from which he can see at any time the condition of business along the team side of the building. A complete desk telephone system is installed for every clerk needing one. Roomy, ventilated lockers are provided for the office force. They are ranged along the walls of the toilet and stationery rooms in the southwest corner of the office. The record room has storage for 5 years' records. Additional space is available above the offices under the roof. Shelving built in conformity with the road's record system is placed in the room as shown in the plan. The two sets along the north wall are for current records, there being room for 8 months' daily records. The compartments are each made just the size of a daily record book and are numbered for the days of the month. Any clerk wanting the records for a particular day can put his hand on the book at once. By this system as many clerks, as there are books for the month can be looking up back records for that month without delaying one another. As the current shelves fill up, their contents are moved over, a month at a time, to the storage shelves.

The plans for an outbound freight-house near this inbound house



Track Elevation. Fifth Avenue Elevation.

FIG. 116.—Part elevations and section through side walls of freight-house, Chicago—Baltimore & Ohio.



Cross Section A-B. Section Through Cooling Room C-D. North End Elevation.

FIG. 117.—End elevation and cross-sections of freight-house, Chicago—Baltimore & Ohio.

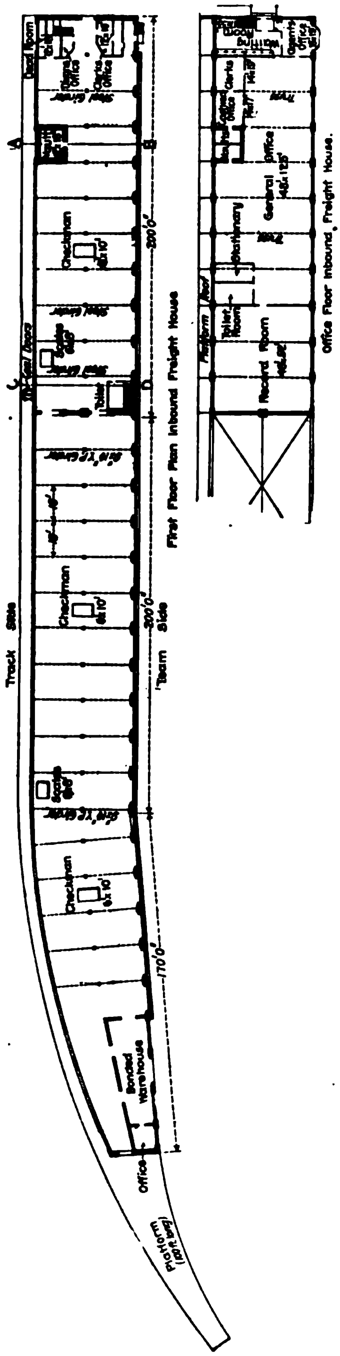


FIG. 118.—Plan of inbound freight-house, Chicago—Baltimore & Ohio.

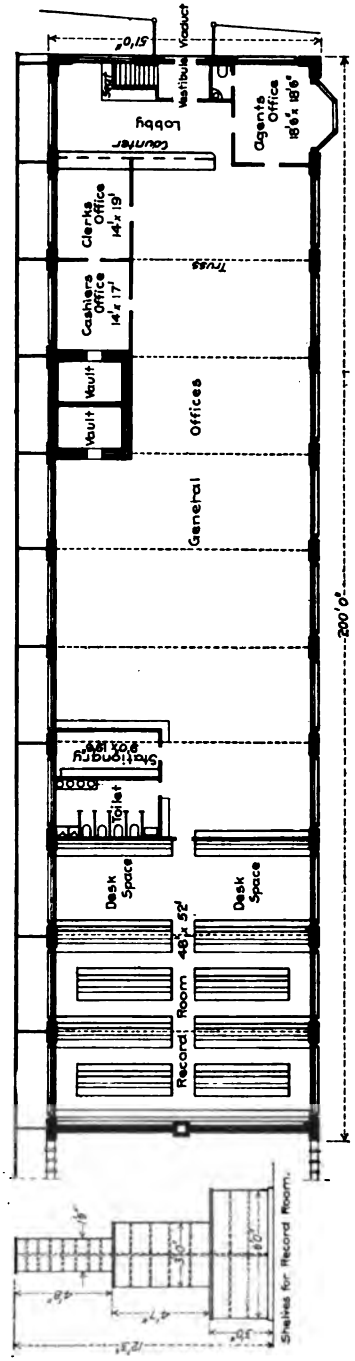
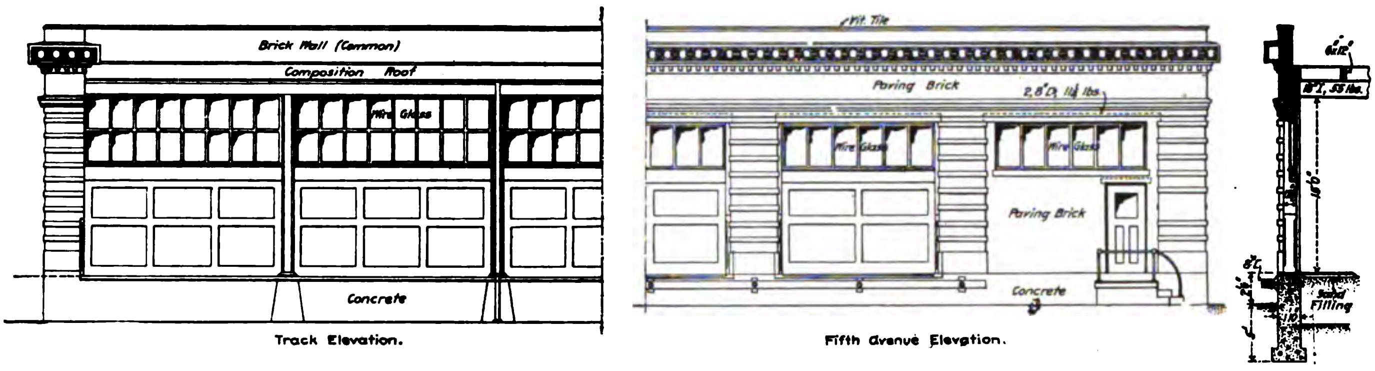


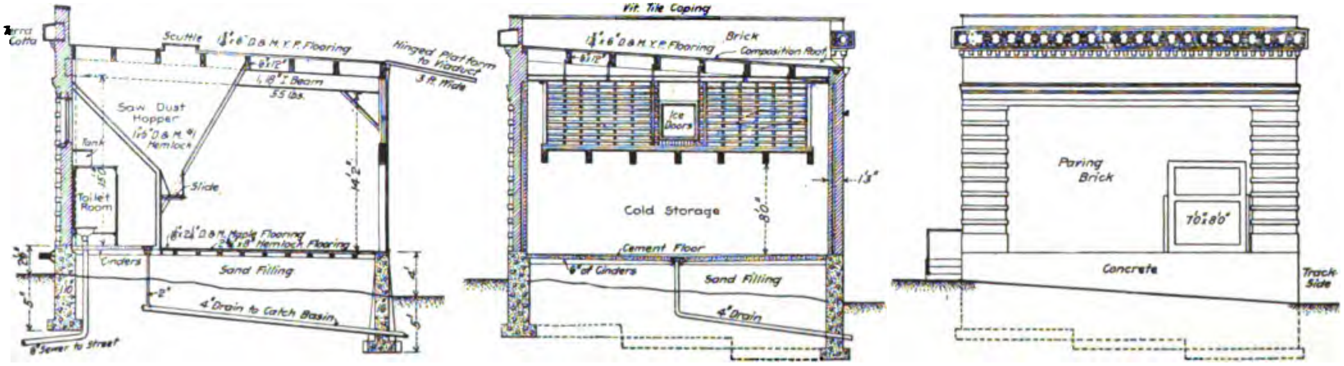
FIG. 119.—Plan of office floor, inbound freight-house, Chicago—Baltimore & Ohio.



Track Elevation.

Fifth Avenue Elevation.

FIG. 116.—Part elevations and section through side walls of freight-house, Chicago—Baltimore & Ohio.



Cross Section A-B.

Section Through Cooling Room C-D.

North End Elevation.

FIG. 117.—End elevation and cross-sections of freight-house, Chicago—Baltimore & Ohio.

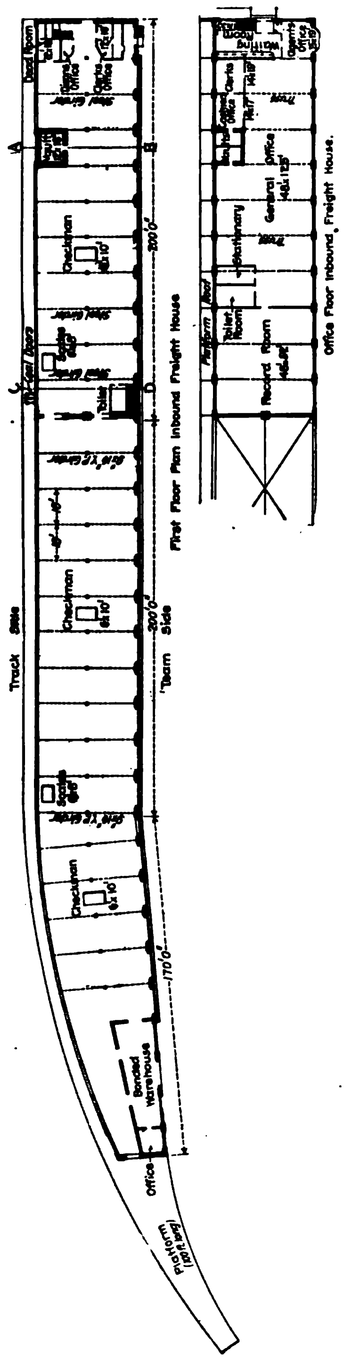


FIG. 118.—Plan of inbound freight-house, Chicago—Baltimore & Ohio.

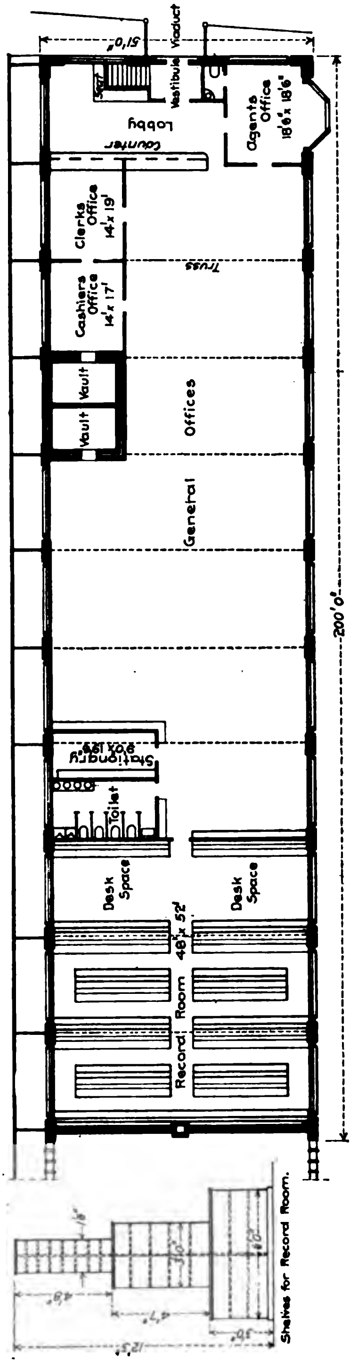


FIG. 119.—Plan of office floor, inbound freight-house, Chicago—Baltimore & Ohio.

have been completed. The distance between the two houses is about 300 ft. The outbound house will be 780 ft. long and 30 ft. wide.

The inward freight-house of the New York, New Haven & Hartford at Worcester, Mass., as shown in Fig. 120, stands on an awkwardly shaped property which was utilized in an unique manner. There was not sufficient room to continue the second track to the end of the house alongside of the first track. The inside track was, therefore, cut off in such a manner as to extend the second track alongside a platform five car-lengths beyond. This enables five cars to be handled while the other two tracks are being switched, and avoids cessation of freight-handlers' work while the house is being worked or "set" by the yard engine.

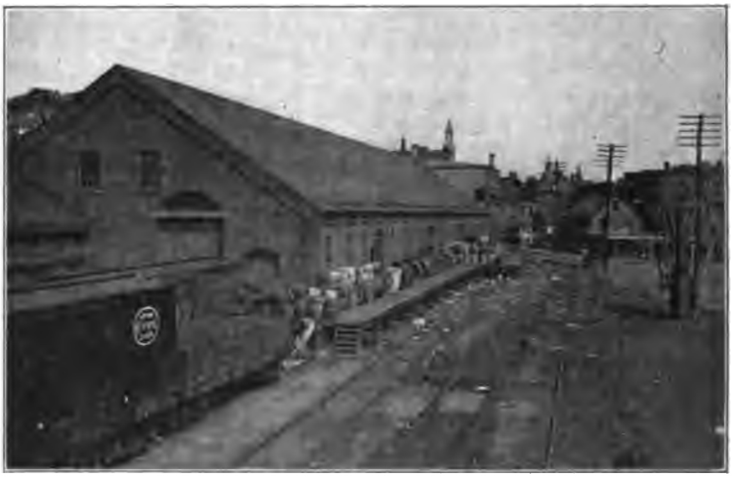


Fig. 120.—Inbound freight-house, Worcester, Mass.—New York, New Haven & Hartford.

There is difference of opinion as to the advisability of putting a narrow platform on the receiving side of outward freight-houses. That it is an advantage to teamsters in getting rid of their loads cannot be questioned. On the other hand, it requires close checking and usually a larger force of receiving clerks than where the freight must be unloaded directly into the house. With the continuous or overlapping-door system, the absence of a platform is not so noticeable to the teamster.

Some roads build freight-houses with one side entirely open and without posts. The doors are so arranged as to slide by each other, enabling an opening to be made wherever the car door stops. This arrangement renders the platform between the outside wall of the freight-house and the first track unnecessary. Where the side of the house is close to the track there is, naturally, some difficulty in spotting cars opposite the doors. The posts may also interfere where the platform is inclosed. The Boston & Maine has wooden freight-houses with side posts set 6 to 8 ft. in from the side of the building. The roof trusses overhang these posts and carry the side walls and doors. The doors are hung on two parallel tracks to be run by each other and also to be run apart to provide larger openings. At water terminals where freight sheds must accommodate vessels, teams and cars, the door problem is complicated. On the water side the doors must be 16 to 20 ft. high and continuous. It is best to hang them outside of the posts though there must be a fender platform outside, not over 2 ft. wide. Doors for admitting teams to the shed must be large, 14 ft. high × 16 ft. wide. An inexpensive and fairly convenient system of doors is to make them in halves and hinged strongly at the top. The lower half, which is counterweighted, slides up inside the upper half and, is held by a crotch hitch to the lower corners of the upper half. The whole is then drawn up to a horizontal position. For sliding door hangers the essential features are strength, simplicity and impossibility of getting off the track.

Where the house abuts on the street at least 20 ft. of good paved roadway, without obstructing the street should be provided. Where the country is level, teams will haul heavier loads, and in building roadways, approaches, etc., this should be kept in mind. While the width of from 14 to 16 ft. has been given for transfer platforms, the class of commodity to be handled should be considered. Cotton, for instance, and other heavy baled goods may be handled to better advantage over a platform from 10 to 12 ft. wide. The height of the transfer platform should be that of a car floor, when standing on a track alongside, which is about 4 ft.

To transfer an occasional car of coal or grain, two tracks alongside each other, spaced 10 ft. 6 in., and with a difference in elevation between the two of 5 ft. 6 in., are used. The commodity to be transferred from the car placed on the high track is shoveled into chutes running into the lower car.

Another example of modern practice in freight-house design is the house erected by the Pennsylvania Lines West in Indianapolis. A general plan, elevations and cross-sections, are shown in Figs. 121 and 122. The property available was L-shaped, with the main stem 50×335 ft. on Georgia Street, and a lateral wing on Delaware Street 40 ×180 ft., with a two-story and basement office building 30×65 ft. on the corner. Entering from the south are 16 tracks, having a total capacity of 88 cars, spaced in pairs on 11-ft. centers and between pairs on 24-ft. centers to allow for a 12-ft. platform between. At the south end all tracks are laid out on a curve of 100 ft. radius to keep them within the limits of the property owned. The floor, built according to the recommendations of

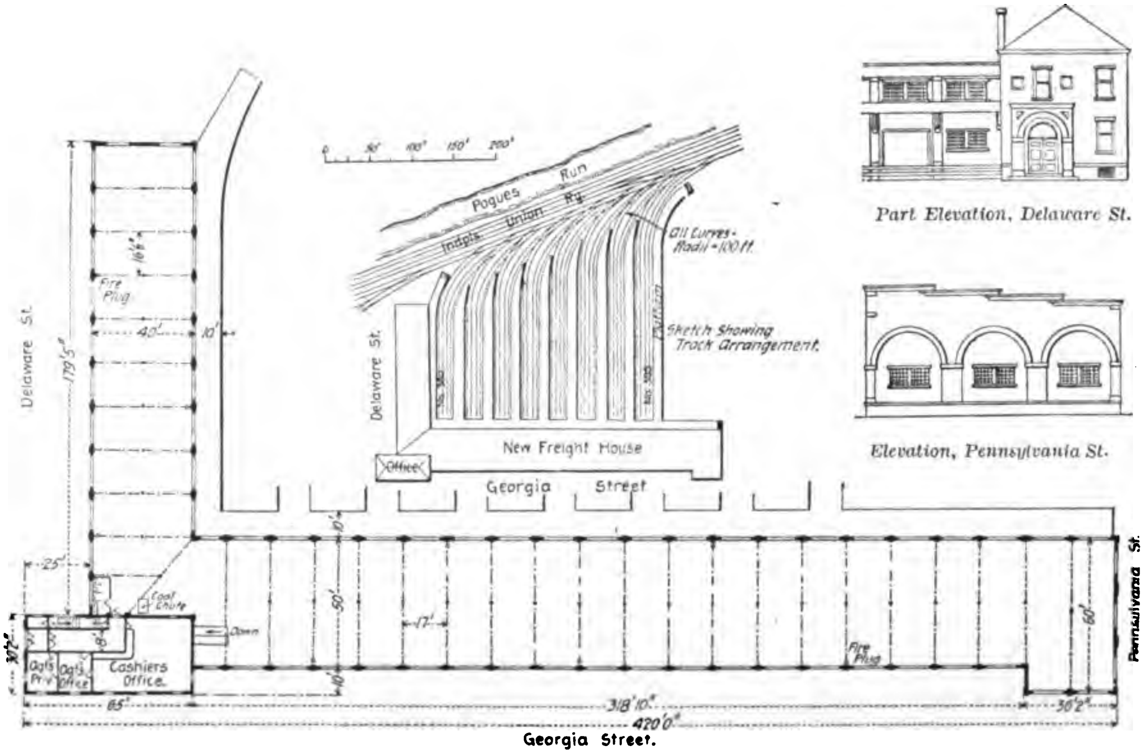


FIG. 121.—Freight-house, Indianapolis, Indiana—Pennsylvania.

the Association of Transportation Officers of the Pennsylvaina Lines, slopes toward the driveways with a 6-in. fall in the width of the building.

In Philadelphia, the Philadelphia & Reading depressed its tracks to eliminate grade crossings and built a brick freight-house 33×308 ft. with an upper floor for the delivery of freight from teams at the street level. Six elevators with platforms 10×4 ft., carry the freight to the lower floor, where it is transferred to cars standing on the house track. For the transfer of heavy freight, direct from wagons to cars, there is a traveling crane, spanning the track nearest the foot of the retaining wall and extending over the side of the parallel street above.

Where the cost of land is greater than that of the additional building and equipment required to install tracks on two floors, such action would seem wise. It is roughly estimated $2 per square foot, extra, above the cost of a one-story house, gives a good mill-construction, slow-burning type of building two stories high. This arrangement could be easily established on a side hill location, but could also be established in flat localities with comparatively little additional expense, and prove a profitable and economical investment. Such freight-houses are frequently a necessity where grade crossings are eliminated in large cities.

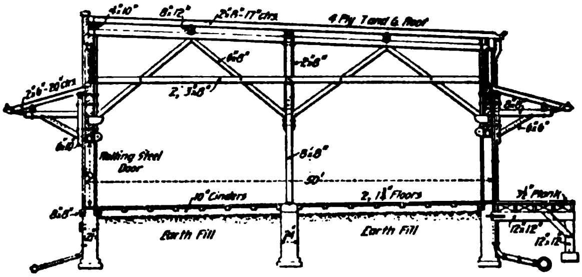


Fig. 122.—Cross-section of freight-house, Indianapolis—Pennsylvania.

Mention should be made of storage warehouses in connection with freight-houses. That of the Baltimore & Ohio Southwestern in Cincinnati, Ohio, is a good example, see Figs. 123 and 124.

A recent development is the new in-and-out freight-house system of the Rock Island, in St. Louis. The property lines require all of the tracks to enter the house on a curve, which made it necessary to swing the north end of the outbound house around to parallel adjacent tracks. The plan and side elevations (Figs. 125 and 126) show the details.

The outbound house is 24 ft. × 570 ft. and the inbound house 46 ft. × 577 ft. The inbound house is two stories high for 208 ft. at the south end, for offices. The outline of a future six-story warehouse for storage of inbound freight is indicated, including the one-story portion of this house, with a total height of 84 ft. The foundations, walls, columns,

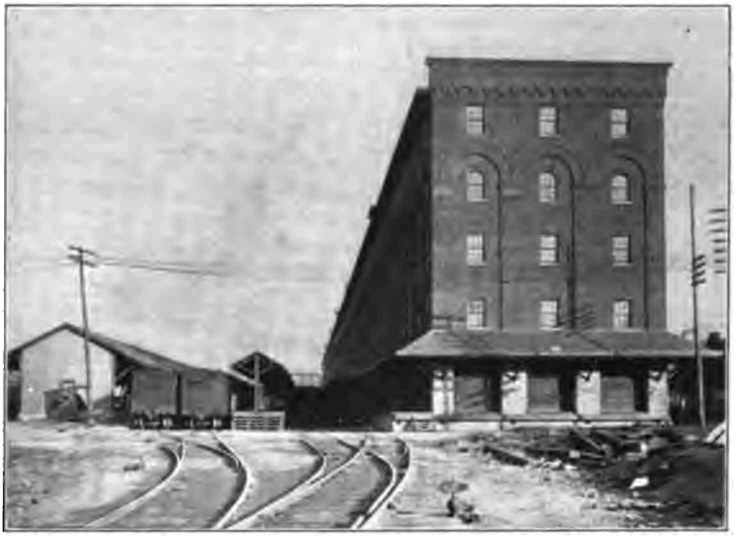


Fig. 123.—Track side of warehouse, showing transfer platform, Cincinnati—Baltimore & Ohio-Southwestern.

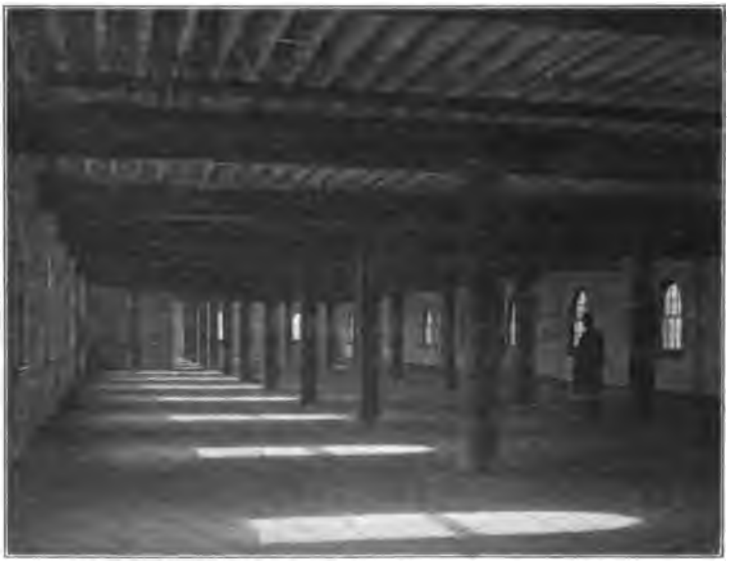


Fig. 124.—Interior of storage warehouse at Cincinnati—Baltimore & Ohio-Southwestern.

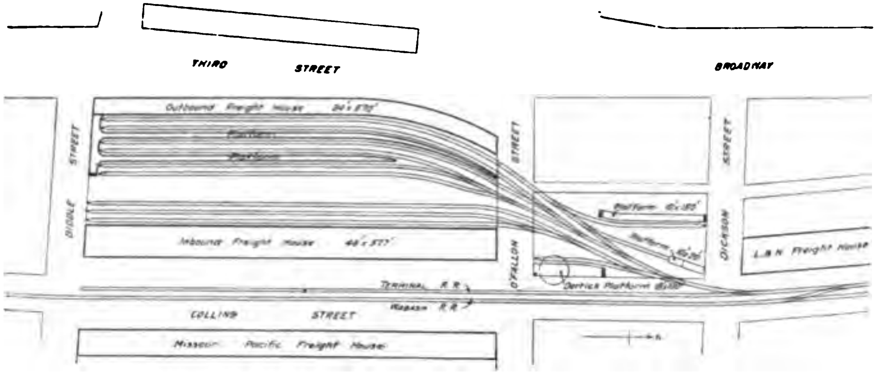


Fig. 125.—General plan, St. Louis freight terminals—Rock Island-Frisco Lines.

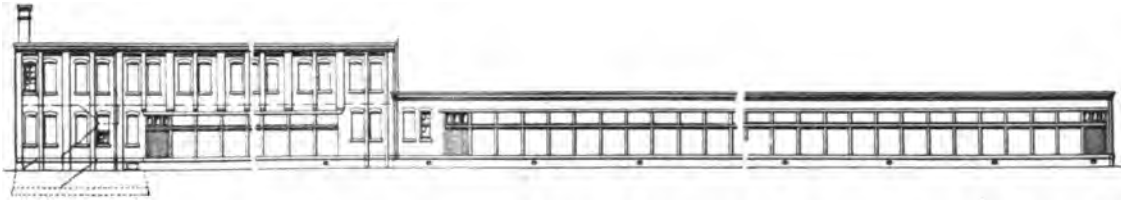


Fig. 126.—Collins street elevation, St. Louis terminals—Rock Island-Frisco Lines.

etc., of the present structure are designed to sustain the load which the additional five stories will impose. This explains the unusual dimensions of these parts of this one-story building. A primary object in the design of the houses was to obtain the most economical construction

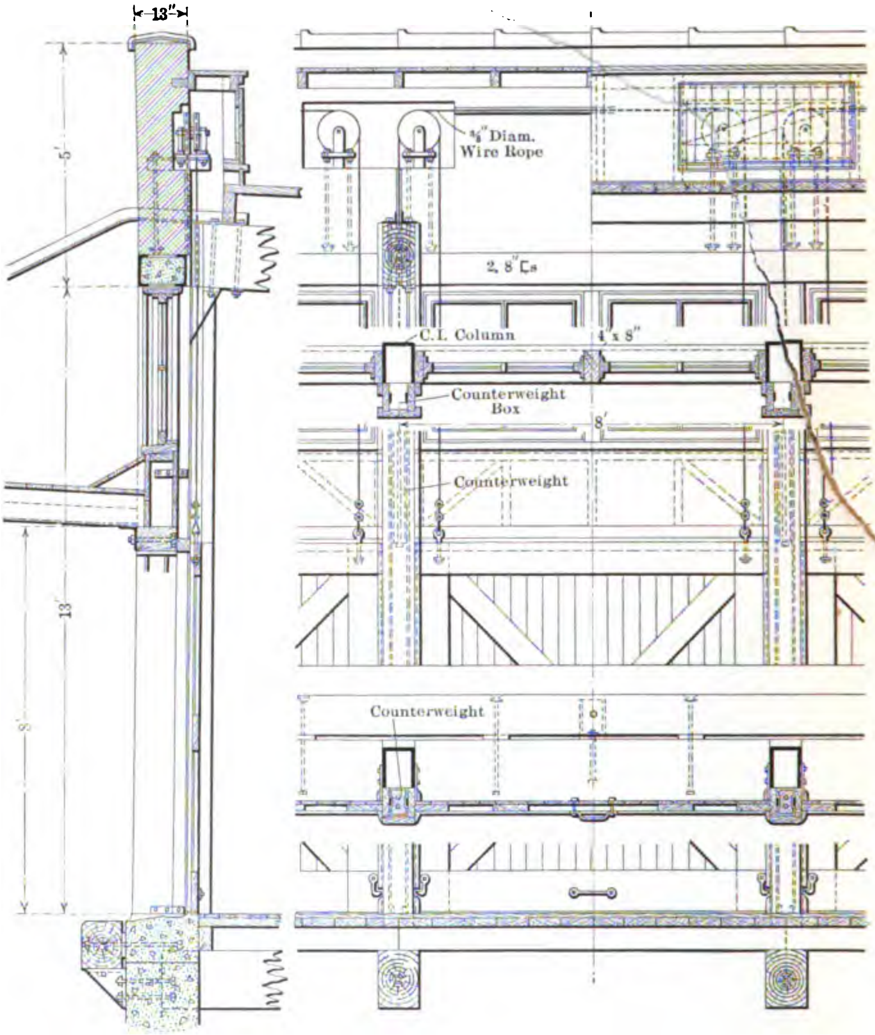


Fig. 127.—Detail of door, team side—Rock Island Co.

consistent with the requirements of the situation. High-pitched roofs, steel frame-work, etc., were omitted and such use made of iron, brick, etc., as compliance with the fire ordinance required. The typical cross-sections included in the illustrations show the character of construction,

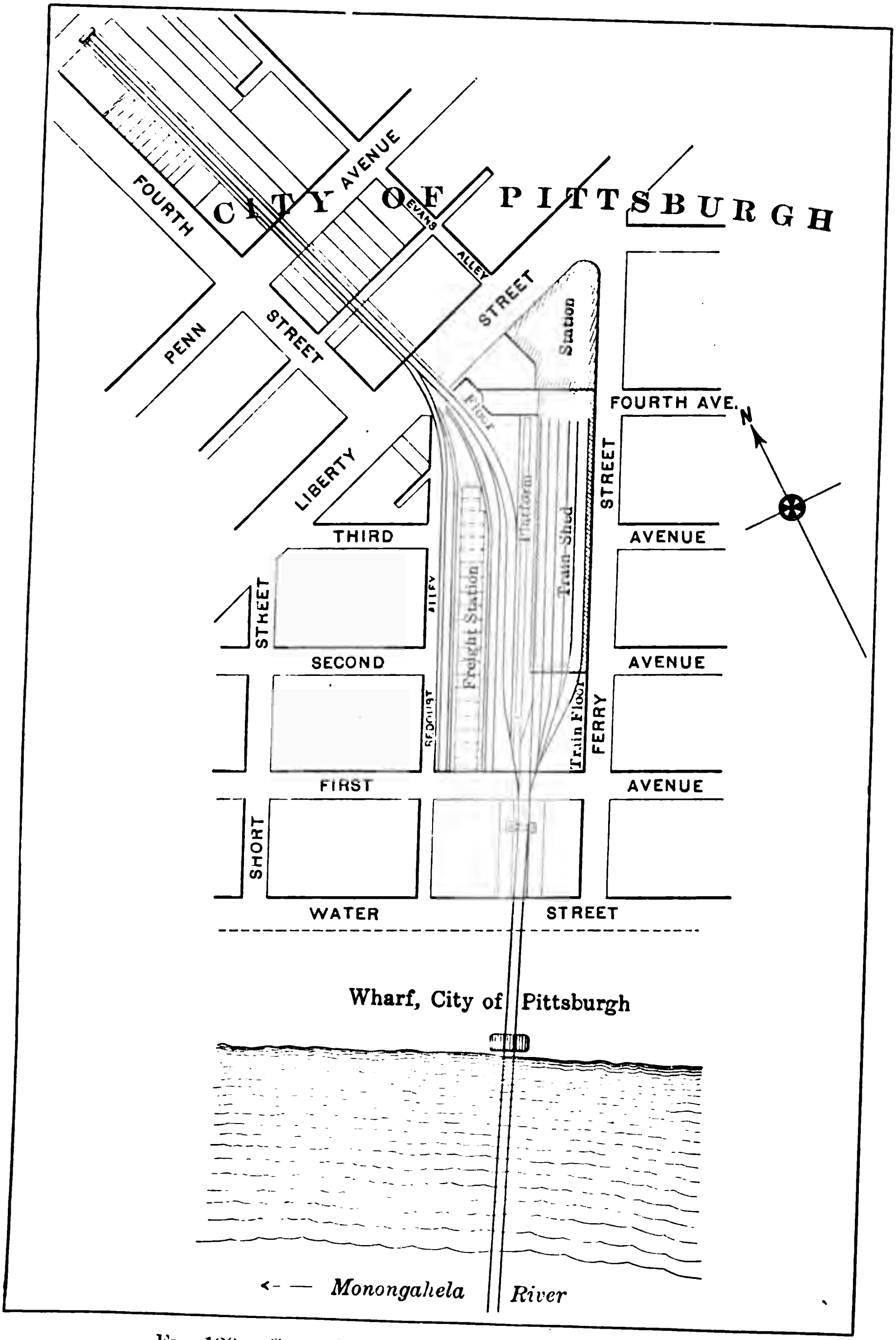


FIG. 128.—General plan, Wabash Terminals, Pittsburg.

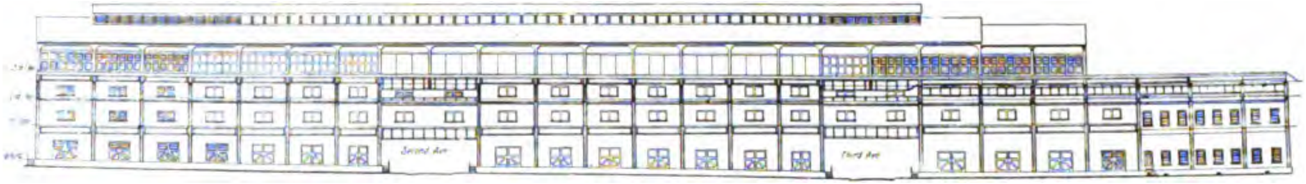
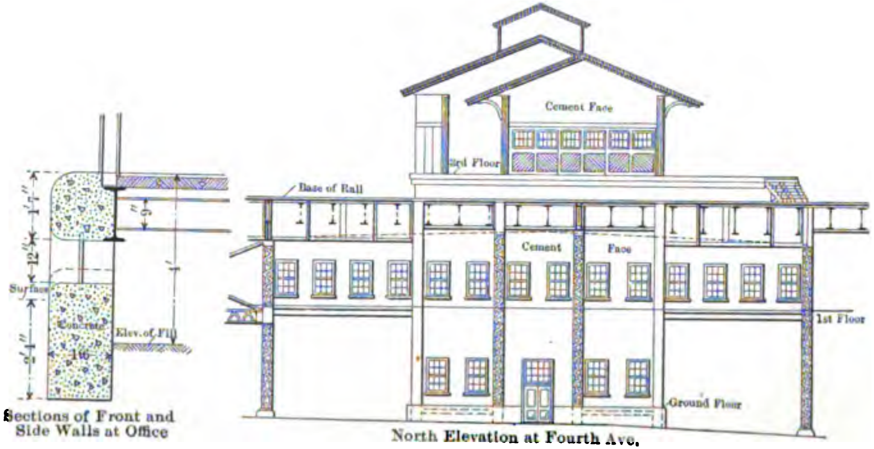


Fig. 129.—East elevation freight terminal, Pittsburg—Wabash.



Sections of Front and Side Walls at Office

North Elevation at Fourth Ave.

Fig. 130.—North elevation, freight-house, Pittsburg—Wabash.

divided on the track sides and counterweighted sliding doors on the team sides. This type of door is cheaper and more satisfactory in many ways than other types of doors intended for similar service. A detail of the door and framing is shown in Fig 127.

The space of 152 ft. between the parallel portions of the houses contains nine tracks and two 8-ft. transfer platforms which are joined at the south end to a 10-ft. platform fronting on Biddle Street. This provides a good arrangement for handling agricultural implements, vehicles, etc. There is an unoccupied space 40 ft. wide in this area which will be graded for a driveway, converting the adjacent track on each side into a team track.

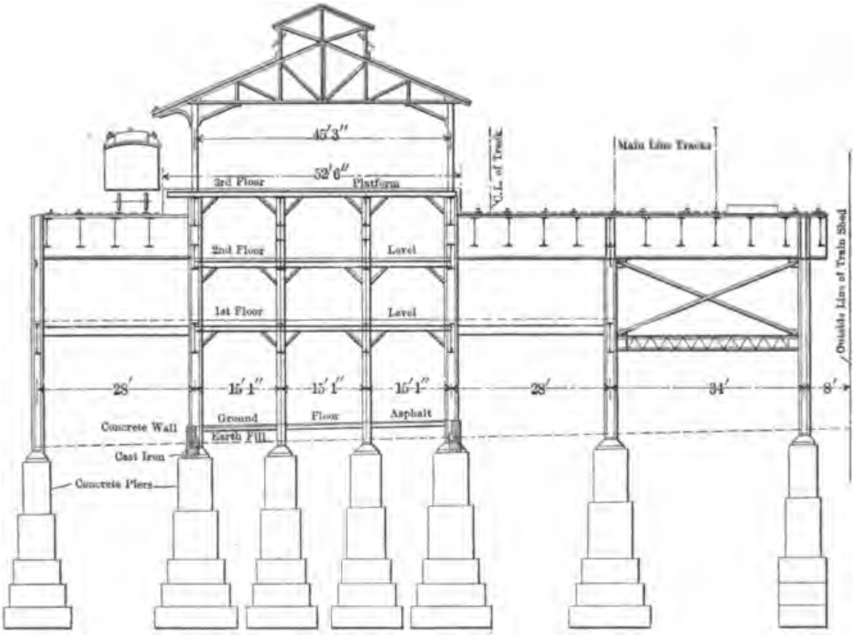


FIG. 131.—Transverse section, freight-house, Pittsburg—Wabash.

The local freight office is located on the second floor of the inbound house. The outer office contains a hundred clerks and special attention was given to the provision of suitable ventilation for their quarters. Ventilating fans of ample capacity are used, so that windows need not be opened at all for this purpose. Ample toilet facilities and all other necessary conveniences for the comfort and accommodation of employees are provided. The buildings are steam heated and electrically lighted. The offices have combination gas and electric fixtures. On the first floor of the inbound house is a room 14.5×21 ft. to be used as a cooper shop for repairing damaged boxes, barrels, crates, etc. The cost is approximately $2,500,000, the greater part being for the site.

General plan, transverse section, north elevation, east elevation, and details of front and side walls at office of the new Wabash freight-houses in Pittsburg, are shown in Figs. 128, 129, 130 and 131. The total width of the freight-house is 145 ft.—length 572 ft. or, including an extension toward Duquesne wye, 831 ft. The track level is elevated to correspond with the entrance of the line to the city from the Monongahela river bridge. The main buildings of the station are of steel and concrete construction, including total floor space of 124,000 sq. ft. The freight terminals are provided with five tracks of 10 cars capacity each, into which loading may be carried on simultaneously; and also with additional tracks for storage and shifting. All told, track room is provided for 125 cars.

Five exceptionally large, high-power elevators are provided. The building is four stories high. The ground floor is used for receiving and delivering merchandise, the two intermediate floors for storage and the upper floor for loading and unloading the cars. Forty doors of extra large size on the ground floor insure the quick handling of freight to and from teams.

On the intermediate floors large doors are provided which open into 14 warerooms. These warerooms are rented to various tenants. The arrangement throughout, from the bottom to the top, is such that the station can be operated with the utmost economy. The genius of the plan is seen in the handling of all incoming freight from the cars directly upon trucks, which trucks are then run upon the elevators and lowered to the wagons or into the warerooms supplied for commission houses or other purposes. This scheme reduces storage and rehandling of freight to the minimum.

Another above-the-ground-floor layout is the freight station and storage warehouse of the Wisconsin Central in Minneapolis, shown in general plan and first floor plan, in Figs. 132 and 133.

The building is 417 ft. long, 79 ft. 7 in. wide on Hennepin Avenue, 66 ft. 1 in. wide at the rear and four stories high. It will be observed that the tracks are below the street grade, which leaves 18 ft. clear headroom under the second story floor beams. The freight is worked in this sub-story on a platform 24 ft. wide and 415 ft. long and is hoisted to the storage by five electric elevators. Four of these are of 5 tons and one of 10 tons capacity. Scales are located in front of every door on this floor. On the other side of this platform, or sub-floor, is a sub-street for incoming freight. Above this is a 34 ft. roadway from Hennepin Avenue to First Avenue north, which is intended primarily for transfer and storage vehicles. The front part of the second story, which is only a little above the street level, contains the offices and vaults and the

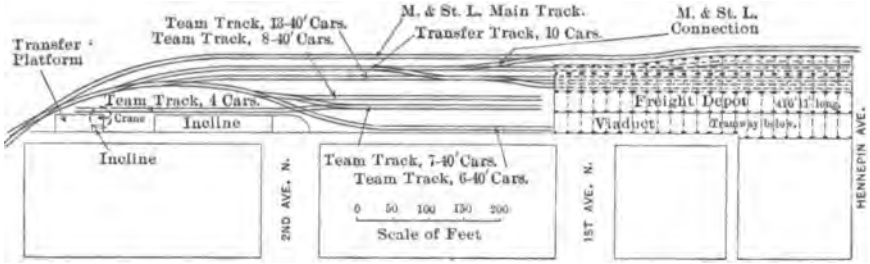


FIG. 132.—General plan, freight-house, Minneapolis—Wisconsin Central.

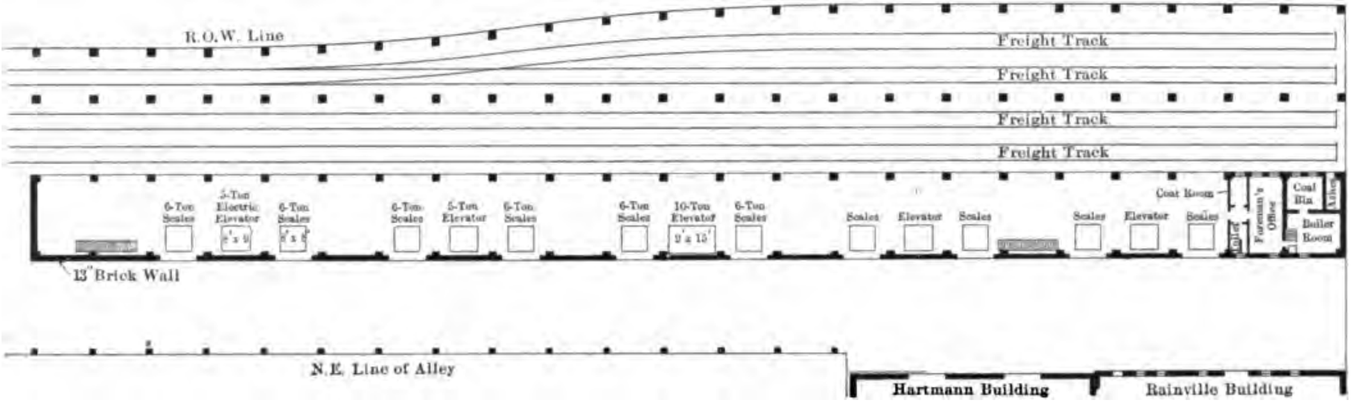


FIG. 133.—First floor plan, freight-house, Minneapolis—Wisconsin Central.

remainder of this floor and the two floors above are for storage, there being about 100,000 sq. ft. for this purpose.

The slab for the driveway is the Turner "mushroom" system. There are no beams and the flat ceiling thus secured allows a good distribution of light and accomplishes a very necessary object—the saving of head-room in the sub-story. This slab is 11.5 in. thick and spans 30 ft. It is reinforced in four directions, directly and diagonally from column to column. A great many advantages are claimed for this system in the matter of speed of construction and cost. The centering for the slab in this, as well as the beam construction, was corrugated iron.

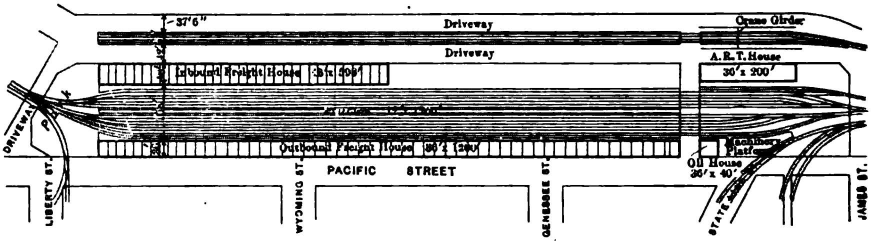


Fig. 134.—General plan, freight-house lay-out, Kansas City—Missouri Pacific.

The Kansas City freight-houses of the Missouri Pacific are large and well arranged on the standard plan of (see Fig. 134) parallel in-and-out houses, seven tracks between and a transfer platform midway. End and side elevations, cross section through offices and of the inbound freight sheds are shown in Figs. 135 and 136. The outbound house is 36 ft. by 1200 ft.; the inbound house 48 ft. by 600 ft. A space of 96 ft. intervenes between the platforms of the two houses, midway of which is an island platform 12 ft. wide and 1200 ft. long, covered by an umbrella shed. The design and construction of the two houses is similar, each having concrete foundation and superstructure of brick and steel, with terra cotta trimmings. The front end of each building is two stories high for a length of 200 ft. These portions have tile roof covering and the remainder tar and gravel. Each house has an elevated platform

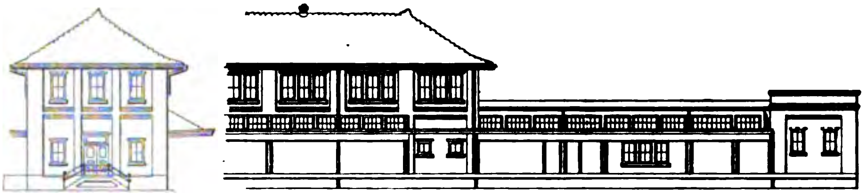
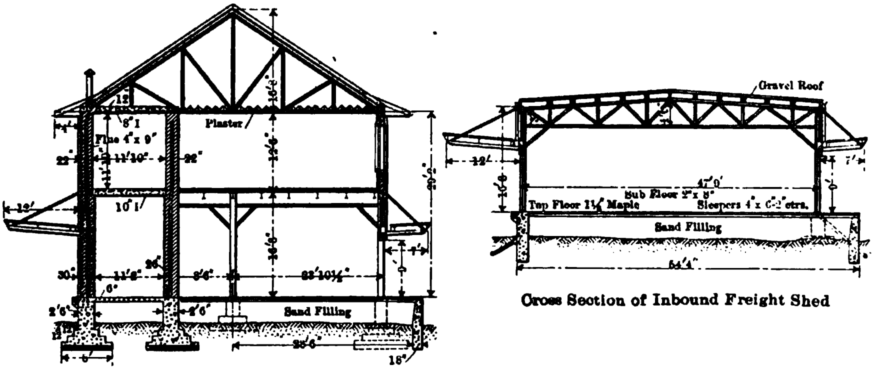


Fig. 135.—End and side elevation, freight-houses, Kansas City—Missouri Pacific.

on the track side 6 ft. wide, protected by a canopy 7 ft. wide; on the team side the canopy is 12 ft. wide. The character of construction is well shown by the typical elevations and sections exhibited herewith. The division offices are located in the outbound house. The local freight offices with lockers and rest rooms, are located in the second story of the inbound house. The outbound house contains 22 sets of scales and the inbound house 7.

South of the inbound house are two driveways, one 42 ft. wide and the other 37.5 ft., with two tracks between. These driveways are of 6 in. of concrete as a foundation, overlaid with vitrified brick on edge, on a cushion of 1.5 in. of sand. At the west, or right-hand end of these driveways is located a gantry crane of 25 tons capacity with a 200 ft. runway electrically operated, for transferring heavy freight between cars, or from cars to wagons and vice versa.



Cross Section Through Offices

Cross Section of Inbound Freight Shed

FIG. 136.—Cross-sections, freight-houses, Kansas City—Missouri Pacific.

The Grand Trunk's new in-and-out freight-houses in Toronto are typical. The buildings are substantial and handsome. They include an office building fronting on Simcoe Street, 44 ft. wide, 180 ft. long and two stories high; an inbound freight-house 50 ft. wide and 955 ft. long; an outbound house 40 ft.×910 ft. and a covered transfer platform between, 16 ft.×910 ft. The office building is a solid brick structure on concrete foundations, with stone trimmings and interior finish of southern pine. It is steam heated, has its own electric lighting plant and is fully equipped with vaults and all other necessary facilities.

The two freight-houses are of similar construction. The concrete piers, resting on concrete foundations, are spaced 15 ft. on centers and carry Phoenix columns with bottom and top castings, which support steel latticed roof trusses. The roof is formed of 2-in.×8-in. rafters, 2-ft. centers, overlaid with 1-in. hemlock boards covered with four-ply felt and gravel roofing. Nine feet above the floor, between columns, is a 6-in.×8-in. girder supported at the ends by brackets riveted to the columns; and at the middle by a 3.75-in. bolt running up through the beams. This girder supports the door track. Above each door, on both sides of the building, are two sashes, 6 ft. long by 4 ft. high. Above these windows are riveted beams carrying 5 ft. of brickwork with a stone coping. The doors are continuous, hung alternately outside and inside, enabling cars and wagons to be unloaded at any point. The floor consists of 7/8-in. maple laid diagonally over 1-in. hemlock resting on 2-in. by 12-in. joists, 2 ft. on centers.

The transfer platform has a row of concrete piers on 15-ft. centers supporting an umbrella roof. The posts are Phoenix columns and angle bar braces carry the roof, formed of 15-ft. purlins covered with corrugated iron. The platform floor is 2-in. plank nailed to 2-in.×12-in. joists. There are three tracks in the space for inbound cars and five tracks for outbound cars. The terminal occupies an entire block of 425 ft. in width. The freight-houses fill 200 ft. of this and the remainder is used for team tracks, of which there are five pairs, with the necessary roadways between. The entrance to the terminal is over a single track which crosses Front Street diagonally and then joins the converging sidings which run across John Street into the terminal.

The plan shown in Fig. 137 is the Lake Shore's freight-houses in Toledo, O. This arrangement is startling. The claim is made that in the house it superseded 29 gangs of six men each, handled 200 cars in 24 hours at a cost of about 45 cents a ton, while this layout enabled the same amount of work to be done with 17 gangs of six men each, for about 35 cents a ton.

A general plan of the South Boston freight terminal of the New Haven, is shown in Fig. 138. This is said to be the largest freight terminal in the country operated by one company in one location. There are 12 houses—7 inbound and 5 outbound—besides 8 piers, hay sheds, grain elevators, flour houses, etc.—a total of 20. The combined floor area of the inward houses is 287,320 sq. ft.; of the outward houses 308,535 sq. ft. and of the miscellaneous houses 234,899 sq. ft.—a grand total of 830,754 sq. ft., approximately 20 acres. The general method of operating is to use certain inbound houses to receive freight trains from certain directions and each outbound receives freight for its trains, routing over certain lines. For example—No. 2 house receives trains arriving on the main line from New York; on the Midland and Western divisions, No. 3 house assists No. 2 and in addition handles perishable freight from the west via Harlem River; No. 10 house is used for freight from Old Colony and Boston division points; No. 5 house is used for outward Old Colony division freight; No. 6 for outward freight to New York and other western gateways.

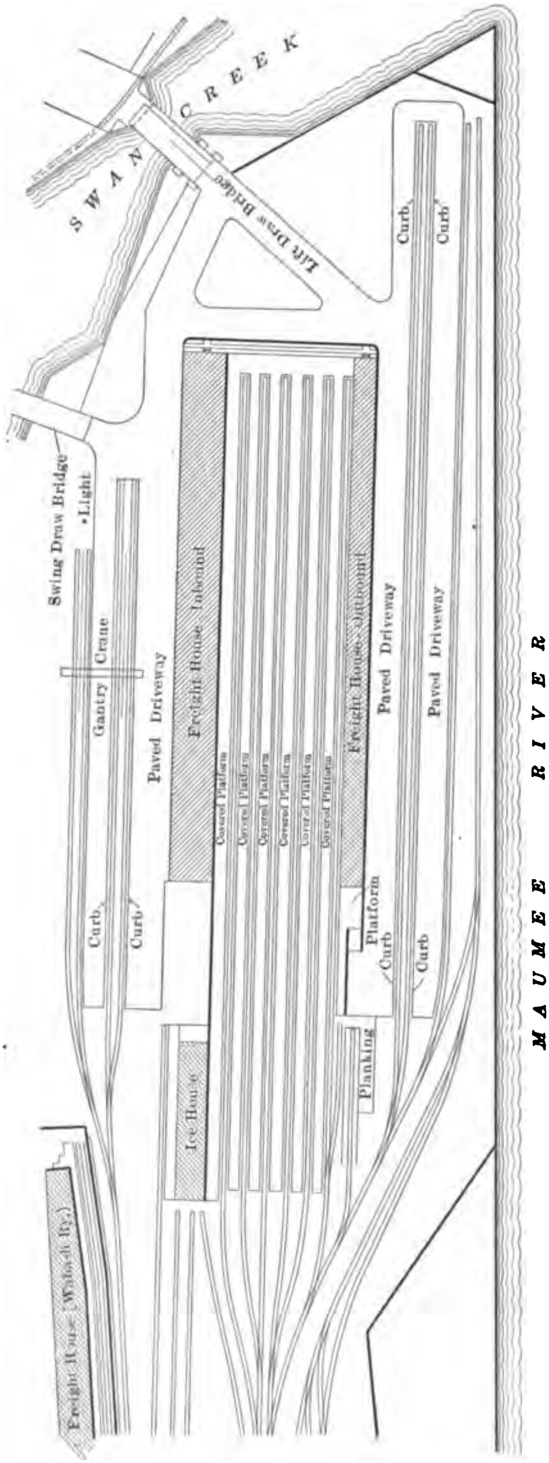
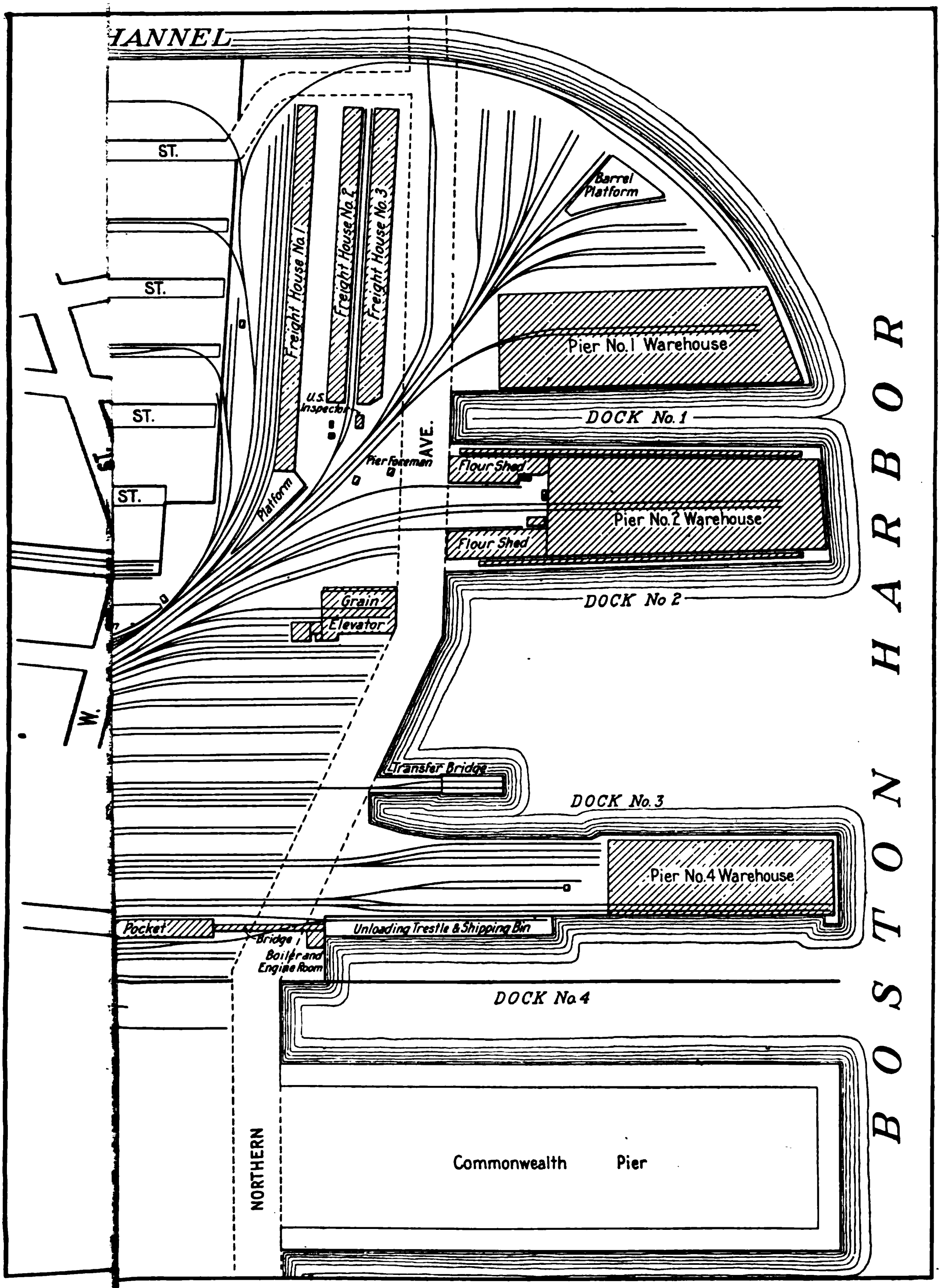


Fig. 137.—Plan of freight-houses. Toledo—Lake Shore.

Each house has a series of numbers for its doors, starting with 01, 02, etc. These numbers are affixed to the house number; house No. 9 would have doors numbered 901, 902, etc. Only two figures are painted over the door on the inside; on the outside, for teamers' guidance, the whole number is shown.


IANNEL
ST.
ST.
ST.
ST.
W. ST.
Freight House No.1
Freight House No.2
Freight House No.3
Platform
U.S. Inspector
Pier Foreman
AVE.
Barrel Platform
Pier No.1 Warehouse
DOCK No.1
Flour Shed
Pier No.2 Warehouse
Flour Shed
DOCK No 2
Grain Elevator
Transfer Bridge
DOCK No.3
Pier No.4 Warehouse
Pocket
Bridge
Boiler and Engine Room
Unloading Trestle & Shipping Bin
DOCK No.4
Commonwealth Pier
NORTHERN
BOSTON HARBOR

CHAPTER XXI

BRITISH FREIGHT SERVICE[1]

Any treatise on the operation of the railways of this country would be incomplete without some reference to the transportation methods of foreign countries. One such country will suffice for the purposes of comparison, and England is selected because its railways are the most interesting to us, and because they are privately owned and operated, like our own, in distinction to the railways of the Continent, most of which are owned or operated by the Government. In many respects, therefore, the railways situation in the British Isles is comparable to that of America.

At the outset it is well to notice the difference in trackage facilities and traffic density. From the following table it is evident that the British trackage capacity per mile of road is much greater than in the United States. They have but 43.5 per cent. of single-track mileage; our single-track mileage is 91.3 per cent. of our road mileage. In Great Britain the total track mileage, including yards and sidings, is two and one-third times its road mileage; in this country our track mileage is but one and one-half times our road mileage, taking the United States as a whole. If, however, the comparison is made with Group 2 of the Interstate Commerce Commission's geographical classification (embracing the States of New York, Pennsylvania, New Jersey, Deleware and Maryland, the territory of the most intensive American railway development), the comparison is not so unfavorable. Yet it must also be remembered that the figures for Great Britain include Scotland and Ireland, with relatively small railway mileage and thin traffic, and they tend to reduce the averages for the British Isles. For England alone the trackage and density are much greater.

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[1] This chapter was written by William J. Cunningham, Assistant Professor of Transportion, Harvard University.

TRACKAGE DENSITY OF GREAT BRITAIN AND UNITED STATES (1909)

Items	Great Britain		United States		Group 2	
	Miles	Per cent. of road miles	Miles	Per cent. of road miles	Miles	Per cent. of road miles
Miles of road	23,280	100.	235,402	100.	23,887	100.
Miles second track	13,121	56.5	20,949	8.7	7,448	31.2
Miles third track	1,500	6.5	2,170	0.9	1,292	5.4
Miles 4 or more tracks	1,721	7.4	1,453	0.6	930	3.9
Miles yards and sidings	14,350	61.6	82,377	35.1	15,720	65.9
Total track miles	53,972	232.0	342,351	145.3	49,277	206.4

As an indication of the use to which the tracks are put in moving trains, a second table is presented which shows the comparative train mile density—that is, the yearly train miles divided by the miles of road. It will be noted that the train mile density of Great Britain is four times that of the United States and twice that of Group 2, the latter being the section of densest traffic in the United States.

TRAIN MILE DENSITY OF GREAT BRITIAN AND UNITED STATES (1909)

Train miles per mile of road	Great Britain	United States	Group 2
Passenger trains	11,400	2,234	5,000
Freight trains	6,640	2,500	4,710
All trains	18,040	4,734	9,710

Having called attention to these marked differences in facilities and traffic density, a comparison of a more general nature will now be made with the British freight ("goods") service. On first view, the most striking dissimilarity is seen in the character of the freight itself and in the design and capacity of their freight cars ("goods wagons"). The freight traffic of England is said to be decidedly *retail* in character, while that of America is *wholesale.* The British merchant, because of his nearness to sources of supply, and the expeditious service of the railways is not accustomed to carry large stocks of goods. The service of the railways is such that goods ordered one day from the wholesale dealer are delivered at the merchant's door early the next day. American merchants, who are situated farther from the wholesale markets, and must allow more time to replenish stocks, would characterize the British policy as "hand to mouth." But the English retailers find that they can rely upon the railways for good service which equals the service of the express companies of this country, and it has had the effect of forcing the railways to handle a large volume of small packages and a relatively small number of car-load shipments.

The difference may be readily seen from the following tabulations which compare the weight of the shipments handled through typical freight houses of England and the United States in one day. The figures for England are taken from "Railways and Their Rates" by Edwin E. Pratt.

Item	Broad Street, London, Eng.	Providence, R. I.	Worcester, Mass.
Consignments	985	1,622	805
Packages	4,427	12,831	10,652
Destinations	53	342	312
Total weight (pounds)	246,000	1,642,000	2,156,000
Average weight per consignment (pounds)	250	1,013	2,678
Average weight per package (pounds)	62	128	202
Average weight to each destination (pounds).	641	4,801	6,910
Cars used	72	170	109
Average load per car (pounds)	3,400	9,658	19,760

It will be seen from these figures that the average weight of each shipment from the Providence freight-house (128 lb.) is twice that of the average shipment through Broad Street, London (62 lb.), and in the case of Worcester (202 lb.) it is more than three times that of Broad Street. In average car load, Providence (4.8 tons) is nearly three times, and Worcester (9.9 tons) nearly six times greater than London (1.7 tons).

To illustrate further the distinctly retail character of British house freight, the following additional statistics are quoted from Mr. Pratt's book: They show one day's business at four of the principal goods depots of the London & North Western:

From	Tons of 2,240 lb.	Consignments		Packages	
		No. of	Weight (lb.) (average)	No. of	Weight (lb.) (average)
Curzon St., Birmingham	1,615	6,110	592	51,114	70
Liverpool Station	3,895	5,049	1,728	79,513	110
London Road, Manchester	1,341	5,522	544	28,277	106
Broad St., London	906	5,201	327	23,067	88

The British shipper of small packages has a choice of three methods of transport. If the package does not exceed 11 lb. in weight he may forward it by parcel post. The postal service rates, which include delivery at destination, are based on a sliding scale under which the charge for 1 lb. is 6 cents; for 2 lb. 8 cents; for 3 lb. 10 cents; and so on, up to 22 cents for 11 lb. The average rate per pound is about 2.5 cents.

The British railways also have a passenger train parcels service. The table on page 303 taken from the Midland Railway public timetable shows the rates and conditions.

The second important difference between the British and American freight service lies in the British practice of collecting and delivering freight. In Great Britain there are no express companies, as we know them, and instead the horse driven or motor vans of the railway companies call at the consignor's warehouse for the freight to be shipped, and at destination deliver it at the door of the consignee. The freight rates include the cartage service at both points, but the shipper has the option of doing his own carting and paying a lower freight rate. For instance, between London and Manchester, 188 miles, the rate on a certain class of goods is 32.7 cents per 100 lb., when the railroad performs the cartage; and 20.8 cents if the shipper elects to do it himself. Generally speaking, however, the railways do practically all of the cartage except in the case of certain bulky or dead freight, such as bricks, coal, creosote, gravel, hay and straw, iron ore, lime, and salts in bulk, manure, peat, scrap iron or steel, sand, slates, turf, wood blocks, etc.

Until quite recently, a large part of the cartage of freight for the railroads was done by large cartage or forwarding concerns, but now the railways do nearly all of this work themselves. The "horse department" is an important unit in the British railway organization. The London & North Western, for instance, has upward of 6000 horses, and employs nearly 5000 drivers, carmen, and cart boys; 250 stablemen, and nearly 300 cartage supervisors, the latter being provided with light

SCALE OF RATES

Conveyance of Parcels by Passenger Trains

The following scale of rates for the conveyance of parcels by passenger trains is now in operation between all stations on the Midland Railway, and with a few exceptions (particulars of which may be obtained on application)between Midland stations and stations on lines in connection, including Irish ports and stations in the interior of Ireland with which through bookings are in operation, and the Channel Islands, via Southampton or Weymouth:

This scale does not apply to and from stations on the lines of the following companies—Caledonian, Glasgow and South Western, Great North of Scotland, Highland, North British (except Berwick, Hexham, Kelso and Morpeth), and Portpatrick and Wigtownshire Joint. For particulars of the rates charged between Midland stations and the stations on these railways, see below.

DISTANCE	NOT EXCEEDING																								
	1 lb.	2 lbs.	3 lbs.	4 lbs.	5 lbs.	6 lbs.	7 lbs.	8 lbs.	9 lbs.	10 lbs.	11 lbs.	12 lbs.	13 lbs.	14 lbs.	15 lbs.	16 lbs.	17 lbs.	18 lbs.	19 lbs.	20 lbs.	21 lbs.	22 lbs.	23 lbs.	24 lbs.	Above 24 lb. for each lb.
	s.d.	s.d.	s.d.	s.d.	s.d.	s.d.	s.d.	s. d.	s. d.	s.d.	s.d.	s.d.	s.d.	s.d.	s.d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s.d.	s.d.	d.
Not exceeding 30 miles	0 4	0 4	0 5	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0¼
Above 30 and not ex. 59 miles	0 4	0 4	0 5	0 6	0 6	0 6	0 8	0 8	0 8	0 8	0 8	0 8	0 9	0 9	0 9	0 10	0 10	0 10	0 11	0 11	0 11	1 0	1 0	1 0	0½
Above 50 and not ex. 100 miles	0 4	0 4	0 5	0 6	0 7	0 8	0 9	0 10	0 11	1 0	1 0	1 0	1 1	1 1	1 2	1 2	1 3	1 3	1 4	1 4	1 5	1 5	1 6	1 6	0¾
Above 100 miles	0 4	0 4	0 5	0 6	0 7	0 8	0 9	0 10	0 11	1 0	1 0	1 1	1 2	1 3	1 4	1 5	1 6	1 7	1 8	1 9	1 10	1 11	2 0	2 0	1

Fractions of a penny charged as a penny.

Including collection and delivery within the usual limits at stations where arrangements for these services are in operation.

Note: An English shilling is equivalent to 24.3 cents U. S money; a penny is 2 cents.

carriages or motor cars so as to be able to move around rapidly from place to place. The Midland is a close second in the extent of its collection and delivery service. On five railways, the aggregate number of horses in this service is close to 18,000 with a corresponding number of drays, vans, automobiles and steam lorries. A typical dray is seen in Fig. 139. On each of the five roads there are more horses than locomotives.

Competition between railways in England has taken the form of improved service and facilities rather than in lower rates. It is so keen, and such has been its effect on the expedition of the service, that a merchant in Liverpool, Manchester, Newcastle or Plymouth, all 200 miles or more from London, may rely for a certainty on receiving at his door by the time he is open for business in the morning, the goods he ordered by telegraph or telephone from his London dealer the previous afternoon. The same service is afforded the more distant points such as Edinburg (393 miles) and Glasgow (401 miles), as well as the principal cities of Ireland, but delivery at these farther distant points is later in the day.

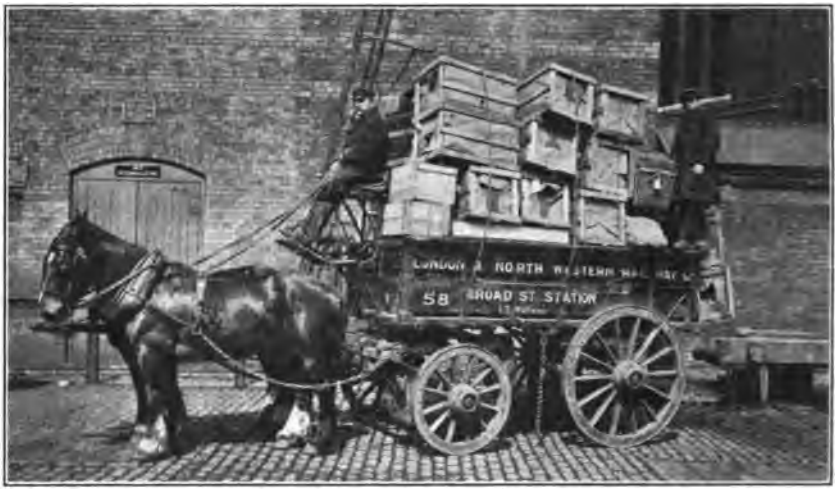

FIG. 139.—Freight dray, Broad Street Station—London & North Western.

The question naturally suggests itself, "What does the Englishman pay for his express freight service?" It is to be expected, of course, that the charges will be higher than we are accustomed to pay here where our railways perform no cartage service, where the character of the freight is different in weight, bulk, and consignment, and where the regularity and celerity of the freight service is hardly as excellent as in Great Britain. To make an exact comparison of rates is out of question because of the dissimilarities in conditions (particularly in the collection and delivery feature) and because, with one exception, the British railways do not compile statistics from which the ton-mile rate may be derived. As a rough comparison, it is interesting to note that the average revenue per ton-mile on the North Eastern of England, the one British road compiling ton-mile statistics, is given as 2.30 cents for 1909. This figure includes, of course, the charge for collection and delivery. In the same year, the ton-mile revenue for the railways of the United States was 0.76 cents. On the North Eastern, each ton was handled an average distance of 23.1 miles, and the average revenue per ton handled was $0.531. The very low average distance indicates clearly the extremely *local* character of the freight. In the United States, each ton was hauled an average distance of 141.9 miles, and the average revenue per ton handled was $1.08. Probably it is fairer to compare the North Eastern with the New York, New Haven & Hartford, as the traffic on the New England railways more nearly approaches the character of the British railways. The comparison will be made clearer if put in tabular form:

Item	North Eastern 1909	New Haven 1911	Ratio	
			No. Eastern	New Haven
Average revenue per ton-mile	[1]$2.30	[1]$1.39	1.00	0.60
Average distance per ton (miles)	23.1	93.8	1.00	4.06
Average revenue per ton	[1]$5.31	$1.30	1.00	0.24
Revenue tons per freight train mile	123	290	1.00	2.36
Revenue per freight train mile	[1]$6.52	$4.03	1.00	0.62

In the collection of freight to be dispatched in trains, the British roads follow methods quite similar to those of the express companies of this country. Each railway has a distinctive card which it distributes to shippers and which is displayed when freight is to be called for by the railway vans. Or the shipper may telephone or otherwise request the railway to send its van. When the freight is offered for shipment, the consignors makes out a consignment note (corresponding to our shipping order) and when it is accepted by the driver of the van the responsibility of the railway begins. The freight is checked by the driver against the consignment note; it is again checked when unloaded from the van to the platform at the freight station, where the goods are weighed, and finally checked once more when loaded from the platform into the cars.

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[1] Including charges for collection and delivery of freight.

From the consignment note the billing clerks make out the invoice (the equivalent of our waybill) and the invoices are sent by train mail ahead of the freight so that they are on hand at destination in advance of the arrival of the freight. At destination, the freight is checked from the car to the platform, delivery sheets are made out, and the driver of the delivery van obtains the consignee's receipt when the freight is finally delivered. This ends the responsibility of the railway.

On account of the density of the passenger traffic during the daytime and the relative infrequency of night passenger trains (night trains are not needed in the country of such relatively short distances and few are run except between London and Liverpool and London and Scotland) nearly all freight trains, particularly merchandise trains, are run during the night hours. From the large freight stations in London they are dispatched in fleets beginning shortly before midnight. Freight is received up to 6 o'clock and from then until 10 o'clock or later the loading and shunting gangs force work at concert pitch. It is the intention to dispatch during the night all the freight collected during the day, and to deliver during the day all the freight received in trains during the night or early morning hours. In London the freight-house labor problem is easy of solution because of the large supply of what is termed "casual" labor, that is, men out of employment who are glad to have employment for one, two, or any number of hours, without any guarantee as to the number of hours' employment to be given. The agent can, therefore, increase or diminish his force of laborers to the need of the hour, and the rate paid is very low compared with wages of American freight handlers. Casual laborers may be engaged at 8 to 10 cents per hour, plus a certain bonus when the tonnage handled exceeds a certain minimum. The bonus system of paying for freight handled works satisfactorily and apparently is not objectionable to the men. Including the bonus, it is a safe generalization to say that the earnings of the British freight-house laborer are about one-third of those paid to similar employees in this country. With certain of the fixed forces the proportion will run slightly higher—approaching one-half of the American rates.

Every night of the week the Midland dispatches 30 trains from St. Pancras Station in London. From Broad Street Station, the London and North Western sends out about the same number in trains averaging 30 cars each. The cars are all equipped with air-brakes and the trains are run at passenger train speed, averaging 40 miles per hour. Of course, this service is given only to the merchandise trains. Trains of dead weight are run at lower speed, say 20 to 25 miles per hour. Because of the very small cars, a merchandise train of 30 cars will weigh in the neighborhood of 300 tons—less than an ordinary passenger train in this country. An ordinary "goods" train is shown in Fig. 140. A train with bulk freight weighs considerably more—say 400 to 600 tons, and in some cases, with mineral trains, an extreme train load of 1000 tons is obtained. Trains of this weight, however, are exceptional. Yet even this maximum load is but one-fifth to one-seventh the tonnage or one of our coal trains with 75 to 100 fifty-ton coal cars.

The freight "wagon" of Great Britain runs on four wheels (two axles) and the great majority have a capacity of 8 to 10 tons. Larger cars are used—many of 20 tons capacity, a few with a capacity of 30 tons. The visitor is inclined to joke about the diminutive British car when compared with the American car designed to carry four or five times as much, and often concludes offhand, without thorough knowledge of conditions, that the adoption of large capacity cars in Great Britain would revolutionize the freight service and substantially reduce operating expenses.

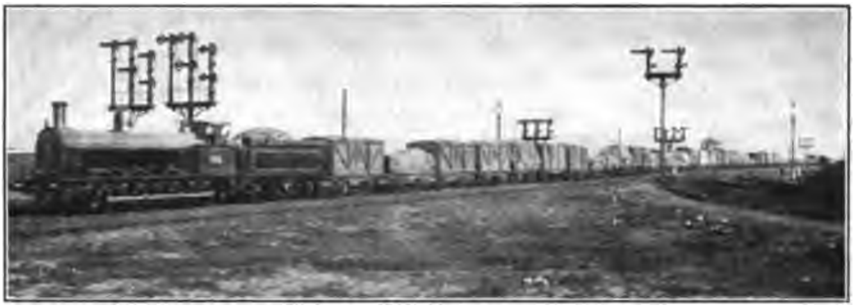

Fig. 140.—"Goods" train—London & North Western.

But this is not altogether true, at least under the present conditions. The small car is the result and not the cause of the retail character of the freight service. Even if larger cars were available and would clear their structures, it would be a long time before their capacity could be utilized, and the road to begin the campaign of educating shippers to the economic necessity of holding cars for full loads would suffer in competition with the road adhering to the small car and sending it forward on schedule whether filled or not. As a matter of fact, it seems impossible now to get a full load in their 8-ton cars. The average car load is ridiculously small, usually about 2 or 3 tons, and efforts to obtain more lading would adversely affect the regularity and speed of the trains, the two factors in which competition is keenest. Such efforts would also reduce the number of through cars to small branch line points, or junctions, increase the percentage of shipments transferred, and otherwise tend to curtail privileges of long standing brought about by competition in service. In Fig. 141 is seen an ordinary four-wheel goods wagon. One of the heaviest (30-tons capacity) special eight-wheel wagons is shown in Fig. 142.

It may be argued that while the reason just mentioned applies to merchandise freight, it has not the same force in its application to the transportation of dead freight, such as coal. But here again there are retail influences which restrict the car load. According to an official statement made a few years ago by the chairman of the London & North Western the average *consignment* of coal is 17.5 tons. Eighty per cent. of the coal shipments are less than 20 tons and many are as small as 2 tons. These instances will show that in order to make the larger car profitable, it will be necessary first to revolutionize the British system of sales and distribution, and unless and until something of that nature is accomplished the 8- and 10-ton car will continue in use. Some

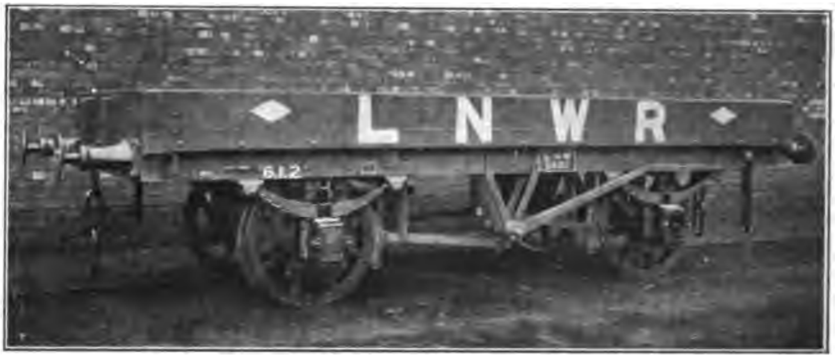

Fig. 141.—Ordinary standard goods wagon—London & North Western.

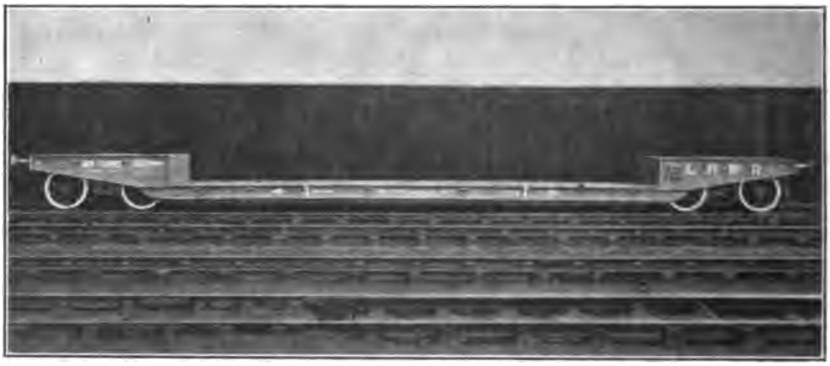

Fig. 142.—Heavy special goods wagon—London & North Western.

of the companies are experimenting with larger cars, but in using them another practical difficulty is encountered, in adapting the scales, chutes, and other loading facilities, as well as trestles and unloading arrangements at destination. These were all designed for the smaller car, and will not permit the use of the larger car, without extensive alteration. The cost of the necessary changes would reach large sums in the aggregate and the expense would not all fall upon the railways. The general view of the Camden "Goods" station of the London & North Western (Fig. 143) gives a fair idea of the station and yard equipment and character of cars used. One of the house-hold goods moving vans is seen in the foreground.

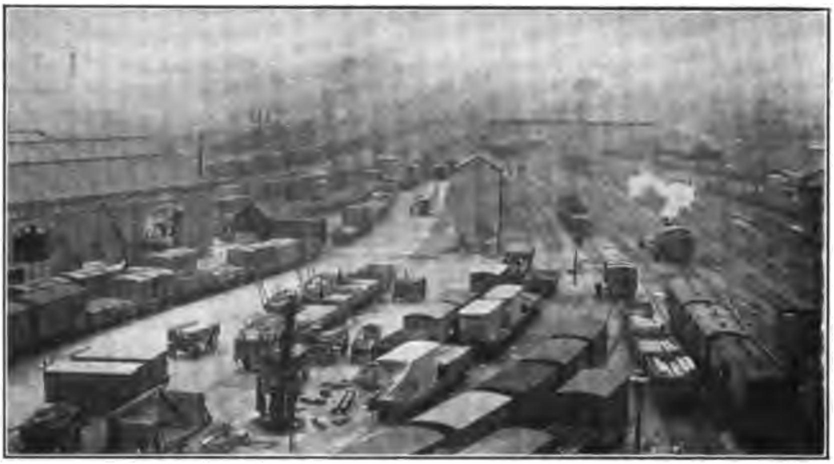

FIG. 143.—Camden goods station and yards—London & North Western.

It is easy to understand, therefore, the disinclination to disturb the present goods- and mineral-wagon standards. But there is still another complication. America is not unique in having its private freight car problem. A large percentage of the mineral traffic of England is moved in privately owned cars, and this fact adds to the difficulty of securing a better car- and train-load. The Board of Trade is implicated as well, since its rules in the interest of uniformity in design of equipment, restrict the dimensions of privately owned freight cars to certain standards. As will be seen from the illustrations, many of the freight cars are open. To protect the freight from rain, snow, or dust, tarpaulin covers are used.

In some ways the British railways, by reason of their small cars, can afford facilities which would be appreciated in this country if our conditions would permit. For instance, the problem of loss and damage to shipments of household goods is solved by an ingenious design of moving van. The body of the van is detachable and when the van load of household goods reaches the freight station it is detached from its horse-drawn frame and wheels and attached to the underframe and running gear of the freight car. In this condition it is moved to its railroad destination where the body of the car is placed on the frame of the horse-drawn van and taken through the streets to final destination. Thus the shipment is handled but twice—once at the house where the goods are loaded and once at the house into which the effects are to be placed. The handling through two freight-houses, and the consequent damage which usually occurs in the process, are eliminated. The same principle is applied in the transportation of fresh fish from wharf to inland market.

In another way, too, the operation of stations and shunting yards is simplified by the smaller car. Being so light, they may be switched by horse-power, or may be easily and rapidly moved by ropes attached to capstans operated electrically or hydraulically. Reference is made to this method in the description of the Broad Street Station, London.

The facility with which the cars may be loaded, unloaded, and switched, and the expedition with which freight is handled through the stations, permit a large volume of traffic to be moved in a relatively small space. If the English roads were operated under American methods of freight handling, the longer period during which the freight remains in the house would call for much more space than is now occupied by the termininal in London, and the high value of property in congested centers of population make this an extremely important factor for consideration. Many of the London freight stations have several floors and the cars are elevated and lowered by lifts. The Great Central has a station with five floors and a basement 16 ft. below the street level. One of the most interesting examples is the London & North Western station at Broad Street and it is believed that the reader will be interested in the following description which is condensed from Findlay's "The Working and Management of an English Railway."

> The Broad Street Station is the city depot and is right in the heart of London. Land being extremely valuable, the line is carried during part of its course by means of bridges and viaducts at high elevation, and in some cases over the tops of houses, and thus reaches its terminus at a point considerably above the level of surrounding thoroughfares. The passenger station having been built on arches, the London & North Western taking advantage of the situation provided themselves with an extensive freight station without the enormous expense of taking land for that purpose in the busiest part of the city, and the freight traffic is handled in the arches under the passenger station, the freight cars being moved on elevators from one level to the other. All along the front of these arches, 14 in number, and including some space beyond them which has been covered in, a roomy stage or unloading bank has been erected. Each arch

measures 340 ft. in length and 32 ft. in width. The length of the stage is 430 ft. and its width 45 ft. From the main unloading stage, at right angles, are erected narrow stages, 12 ft. × 240 ft., with a track on each side, extending through each arch, these tracks being connected with a cross line by means of which cars can be turned upon small turntables and taken to one of the hydraulic lifts.

On the further side of the arches some additional space has been acquired on the street level to form an open freight yard, on one portion of which a lofty warehouse has been erected for the storage of goods awaiting delivery or to be held in transit.

Traffic arriving from the country for delivery in London is called "up traffic." That sent from London is known as "down traffic." The "up traffic" consists largely of provisions for supplying the early markets with fish, meat, poultry, butter, eggs, and other perishable commodities which have to be delivered as early as 4 a. m.; also general merchandise purchased from manufacturers in the Provinces the previous day and expected to be in the city warehouses by 9 a. m.

This part of the business is conducted in the warehouse, the ground floor of which is staged so as to form a platform upon which the goods can be sorted and transferred from the cars to the street vans. This platform is open on both sides so that vans may be backed up to it on one side and the freight cars run in on the track on the other side. The invoices (waybills) are passed through the delivery office where each is entered in a book, stamped with a progressive number, timed as to arrival, checked as to the correctness of rates and extensions, and is then passed to a marking clerk who marks against each entry on the invoice the position of the freight on the platform. The whole of London is mapped out into districts, each of which is designated by a letter and number, and the platform is divided into sections to correspond with these divisions. When the invoice is marked by the marking clerk it is passed to other clerks who extract from it and enter on the car man's delivery sheets such of the entries as refer to the particular section of the city with which he is appointed to deal, and by this process the whole of the entries for delivery to a particular district are brought to a focus, although the goods may have arrived from hundreds of different stations and entered upon as many different invoices.

When the invoice reaches the platform from the delivery office, the goods are unloaded from the cars, checked with the invoice, and trucked to their positions on the platform according to the marks on the invoice. When the goods are taken from the platform to the vans they are checked against the car men's delivery sheets and finally taken in the vans to their destinations.

The "down" or outward traffic is handled in the arches. During the day the tracks alongside the platforms are filled with empty cars into which the goods are loaded as they come in during the afternoon and evening. As fast as the "up" goods are unloaded at the warehouse platform, the empty cars are transferred to the "down" arches. As the loaded vans come in at the gates they are placed in position for unloading on the platform. The consignment notes (shipping orders) relating to each load are checked against the freight as it is unloaded and the freight is weighed on weighing machines stationed at regular intervals along the platform. Each arch is reserved for goods for certain stations or districts, and as the freight is unloaded from the van the checker directs the trucker where the freight should be trucked. From the platform the goods, when deposited in the proper location by the trucker, are placed in the cars by the loading gang, which consists of a checker, a loader, a caller-off, and two porters. When the goods are in the cars the consignment notes are taken to the shipping office and from them the invoices are prepared. The freight cars, when loaded, sheeted (with tarpaulin covers) and marked, are run out at the further end of the arches by means of ropes attached to hydraulic capstans, turned on turntables, and elevated on hydraulic lifts to the upper level, where in a group of ten long sidings, and still by the aid of hydraulic capstans, they are marshalled into trains and dispatched. The process of marshalling is facilitated by arranging the cars in the arches in train order. In some cases the vans are driven alongside the cars and the freight unloaded directly from van to car.

The station embraces an area of 17 acres, including 3.5 acres on the high level. It has a capacity of 820 cars, of which 487 can be placed in position for forward loading on the low level at one time. On the average 456 loaded cars are received daily and 508 are forwarded. Altogether the station is equipped with 183 cranes — one of 10 tons capacity, one 5 tons, and the remainder of .5 tons or less. These are distributed to assist (1) in loading from vans to cars and vice versa; (2) from vans to platforms and vice versa; and (3) from cars to platforms and vice versa. The two high-power cranes are located in the yard to unload exceptionally heavy articles.

In order to give the reader some idea of the details of design, the following description of the North British freight station and warehouse in Glasgow is quoted from "The Engineer" of London:

"The special feature of this warehouse is its equipment for the handling of traffic and the unusually large electrical plant which is provided, with a view to the rapid and easy disposal of a heavy volume of goods. The tracks inside the building are arranged in sets of three, the two outside tracks of each set being used for loading purposes, while the center track is used for removing empty cars from or feeding loaded cars to the outer tracks. As no locomotives are permitted inside the warehouse, on account of fire risks, special means had to be adopted for the handling of cars. Thirty electric capstans, each capable of exerting a pull of 1 ton, or hauling about 100 tons on the level at a speed of 250 ft. per minute, have been laid down. Each is worked by a 26-h. p. motor running at 400 revolutions per minute and driving the capstan head through a worm gear reduction.

The movement of the cars from the outer track to the center track and vice versa is effected by means of electric traversers running on rails laid at right angles to the wagon rails. The cars are pulled on to the traversers by means of the electric capstans, one at a time, and traversed across to the required track, where they are then run off, the traverser then being removed back out of the way. There are eleven of these machines, of the surface type, 12 ft. long exclusive of the ramps and arranged to travel on three lines of rails. They are capable of carrying loads of 20 tons at a speed of 100 ft. per minute and are driven by 10-h. p. motors. There are 15 overhead revolving cranes—thirteen of 1.5 tons and two of 3 tons capacity, which are arranged to work over the ground floor and are used for loading and discharging both cars and wagons and for general lifting and transport purposes about the various loading platforms. All the crane runways are parallel to each other and at right angles to the railway tracks, so that whenever the necessity arises a number of cranes may be concentrated on one row of cars, insuring rapid discharge with a minimum number of cranes. Each crane consists of a traveling gantry 21-ft. 10-in. span, from which is suspended the balanced revolving jib, having a radius of 23 ft.

Facilities are provided on the upper floors for the rapid handling of goods by means of electric transporters traveling on runway girders suspended from the roof girders. The loads are lifted from the railway trucks in the loading way through wells in the floors and are distributed by the transporters over the area of the floor covered by the respective tracks. There are four of these transporters for each floor, each capable of lifting 1.5 tons. The hoisting speed under full load is 100 ft. per minute, accelerating to about double this speed for light loads; and the traveling speed is 350 ft. per minute. The height of lift for the transporters on the first floor is 34 ft. and for those on the second floor 50 ft.

Six jiggers, or short-travel transporters of 1.5 tons capacity, are provided on the uppermost floor, so placed as to command the roadway on the floor below along the north side of the warehouse through trap doors in the floor. The three remaining are placed in outside walls on the south side of the building and may be used for raising goods from the yard to either floor and conversely. The general design of the jigger is similar to that of the transporters, with the exception that the controllers are fixed on the warehouse floor near each track and the operator's cage is dispensed with. The travel of each jigger is only 10 ft. and the height of lift is 50 ft. The hoisting speed for the full load of 1.5 tons is 100 ft. per minute and the traveling speed 200 ft. per minute.

In addition to these appliances, nine electric hoists, each 1.5 tons capacity, have been provided—four at the west and five at the east end of the building—which are available for use on all the floors, communicating direct with the loading tables on the track floor. There are two other hoists of the same capacity for the use of the portion of the basement lying to the east of the building proper, under the yard, and they communicate direct with two loading tables provided with special siding accommodation, apart altogether from the warehouse tables and sidings.

All these elevators are arranged to carry the maximum load at a speed of 150 ft. per minute and they are each driven by 26 E. h. p. motors running at 400 revolutions per minute. The cages are steel framed, lined with timber, and kept in position by suitable guides fixed to the sides of the shaft.

To the south of the warehouse lies the general loading platform, which can accommodate more than 60 cars. A considerable portion of this is roofed over, so that it forms to all intents and purposes a useful extension of the warehouse proper. Close by there is a 40-ton electric traveling gantry crane for handling heavy machinery and special loads. Small loads requiring the use of crane power are handled by means of hand cranes in the yard, the capacity of which varies from 5 tons downward."

In concluding this chapter on the British freight service we may ask ourselves, "In what particulars can any of their practices or ideas be applied to our own problems?" The answer is difficult. We may beg the question by stating that English methods are adapted to English conditions and not to America. Dissimilarities in conditions make comparisons of doubtful value. There is, however, a feeling among a few railroad men that the railroads of New England might profitably take a leaf from the note-book of Old England and experiment (1) in the collection and delivery of freight; (2) in the use of the small capacity car; and (3) in the running of express freight trains. In another chapter, reference is made to the Baltimore and Canadian experiments in collecting and delivering, but it has not been tried in New England where conditions are perhaps more favorable. New England merchants would appreciate the advantages of over-night express freight service and the use of small cars would make such service more feasible. The preponderance of l.c.l. freight in New England might justify the small car and something approaching the British express freight service, but such service would cost more and call for higher rates, and it is a question whether the shippers would stand for higher rates even if the increased value of the service (which would be equivalent to shipping by express) would justify the English scale of charges. If the Interstate Commerce Commission succeed in their efforts to reduce the rates charged by the express companies, it may be that the railways will be forced to take over that class of business themselves, and in that event, something like the British express freight service may be found feasible and desirable.

CHAPTER XXII

TRANSFER STATIONS

The daily amount of freight handled between two stations may be small; possibly consisting of one or two packages of a hundred pounds weight each. Where these stations are located on the same district and on the line of a way freight's regular daily run, the packages would be loaded and unloaded to and from the peddler cars by the way freight crew. Freight destined to or beyond the station at the end of the way freight's run would be loaded into one or more cars for that station, and unloaded there by the station forces. At the larger intermediate stations, where a sufficient amount of freight originates, cars are loaded up for the station at the end of the run, or to a point beyond. These are usually termed straight cars and the contents are not handled by the train crew. The cars loaded or unloaded by the trainmen are variously known as peddler cars, way freight cars, scrap loads, or local cars. To facilitate the handling of this l.c.l. freight it is customary to establish transfer stations at convenient points where freight from various stations and converging lines centralizes and may be consolidated into straight cars—that is, solid car loads to stations for which enough freight may be running to justify such cars, and into local or peddler cars to be distributed over the various way freight runs, and for other transfer stations which in turn may repeat this loading.

As already mentioned in a previous chapter, in England, "tranship" stations take the place of the American transfer station. Because of the small 8-to-10-ton capacity "goods wagons" of Great Britain, there is little necessity there for rehandling the freight between the point of shipment and final destination, as straight carload shipments are made in most cases where fast time is a desideratum. The heavy load and the large capacity cars of American railways have their advantages, and likewise their disadvantages. Unless freight in considerable quantities is moving between two points, the large capacity cars have to be loaded into and out of the many transfer stations which are necessary to enable the heavier loading of cars by consolidation of their lading. Each handling at a transfer station means an added expense in the freight handling and checking with the waybills, as well as extra expense in the yard switching service. The opportunities for loss and damage to freight and for pilfering increase with the number of transfer points. Each transfer adds also to the delay in the movement of freight and cars. On the other hand it permits the consolidation of car loads with regard to train service, and, in many instances, affords better time by enabling loading to final destinations.

In the handling of l.c.l. freight it is the general practice to load straight cars for stations to which the movement of traffic is large enough to justify them, and peddler cars for movement on diverging local or other designated trains. In addition, the larger shipping stations "scrap" load to transfer stations located at various operating terminals and junctions, shipments consigned to points on lines diverging from such transfer stations, to which the business is not heavy enough to justify the loading of a straight car for any one station. When these scrap loads are received at a transfer station, they are worked into that station's schedule cars, making straight cars for the heavier receiving stations; and peddler cars, loaded in station order for less important stations.

The transfer station is usually operated in conjunction with a freight station, although the larger and more important transfers are often operated independently. The organization, if operated independently, is planned after that of the ordinary freight station, except that straight gangs of truckers, each with a foreman, are employed; also checkers, who are responsible for checking both the inward and outward handling. A regular "set-up" is made daily at a transfer; the inward cars, when unloaded, ordinarily being utilized to make the outward "set-up," unless the unloaded car is routed by a different line or junction than the regular "set-up" car would travel.

The set-up may not be the same each day. Two-day and, at times, three-day cars may vary it. For points to which there is not sufficient freight to load a car daily, freight may be held two or even three days to obtain enough to secure a straight car, thereby avoiding delay and rehandling after the car leaves the transfer. This practice often makes it necessary to hold cars at the transfer for that purpose, unless storage room is available in which to care for it. Such storage room is usually provided, and should be in every instance, unless the transfer is a part of the regular freight station, in which case the freight-house room may be utilized.

To illustrate the general principles of a transfer set-up and its handling, let us assume a platform 20 by 560 ft. with two tracks on either side, giving length for 14 cars on each track and a set-up of 56 cars by working through the cars on the tracks next alongside the platform.[1] Cars may be placed on one track for a train of 14 cars, or by "doubling over" on two tracks for a train of 28 cars or less. If the cars are loaded with those on the head end of one track for first station reached, and so on, to the end of that track and following from the head end of the second track, and the first-track cars are drawn out and set over on the second, the train will leave properly made up.

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[1] That is, using the open doorways of the cars nearest the platforms and gang-planks as a passage-way to reach the cars on the second track.

The general organization, working force and methods of operating transfer stations are explained in Chapter XXV. Usually the freight-house and transfer are adjoining and operated under one general head.

One of the heaviest transfer stations is that of the Pennsylvania at Waverly, N. J. The platform is about 1000 ft. in length; eight tracks are worked, with a placing capacity of 196 cars and an average daily outward movement of 230 loads. A car for a certain destination occupies the same position daily, except when the freight is heavy, awkward in shape, fragile, or otherwise undesirable to handle in the usual manner. In such cases the position may be changed.

The freight is handled on the piece-work basis, the freight handlers receiving about 14 cents per ton. The total cost of handling is close to 30 cents. Under the piece-work method, better wages are earned, about three-fourths the usual number of handlers are required and occasional "hustling" is indulged in.

The transfer of the Washington Southern in its Potomac yard near Alexandria, Va., is 37 by 640 ft. The platform is covered and equipped with three sets of platform scales, electrically lighted, and provided with portable electric lights to be used in cars. The tracks permit 124 cars to be set up. About 115 cars, in and out, are handled daily, averaging 465 tons, and the average cost is 21 cents per ton. Eight tracks are used, four on each side of the platform. There are no island platforms, and it is therefore necessary to spot the cars. A plan showing the location of this transfer will be found in Chapter V.

The proper arrangement of car loading, from freight-houses, transfers and by local freight crews, to secure a maximum of car load with a minimum of car-mileage, and to reduce handling and other expense on a busy line, is a complicated problem. Where a road is cut up by many side lines and junctions, any arrangement must have some disadvantage, and all require constant revision to meet changing conditions.

The system in use on the New York, New Haven and Hartford is necessarily elaborate because it is planned to meet the most complicated and exacting conditions of handling package freight, in this country. The instructions are contained in a book which, from the color of its cover, is commonly known as the "Red Book"; the only additional instructions being contained in small pamphlets applying to each large transfer station and showing the outward loading and routing for such stations. The "Red Book," under heading "Instructions for loading l.c.l. freight to and from all stations," takes up one division after another, starting with "Instructions for loading l.c.l. freight—New York Division." The first column heading reads,

"Load l.c.l. freight from
New York piers 45 and 50,
Long Island R. R. via pier 50,
Harlem River, N. Y.
N. Y. C. & H. R. R. R. via Port Morris, N. Y. (when less than minimum), as follows:

NEW YORK DIVISION

Way Freight.—For all stations.

SHORE LINE DIVISION

Way Freight.—For stations Glenbrook to West Haven inclusive, except South Norwalk and Bridgeport.

South Norwalk.—For South Norwalk, Conn., and stations Norwalk to Bethel and Ridgefield inclusive.

Bridgeport.—For Bridgeport, Conn.

Hartford.—For stations Windsor to Suffield and Springfield inclusive; Wethersfield to Essex inclusive except Middletown.

Westfield.—For Westfield, Mass., and stations to Holyoke, Williamsburgh, Turner's Falls, and Shelburne Falls inclusive.

New Haven.—For all other stations.

PROVIDENCE DIVISION

New Haven.—For stations Midway to Norwood, R. I., inclusive; Worcester, Mass.

Hartford.—For stations Unionville to Ashland inclusive, except Bellingham Junction.

[1]*Mansfield.*—For stations Hebronville to Canton Junction inclusive; Perrins and Rumford.

[1]*Providence.*—For all other stations.

BOSTON DIVISION

[1]*Providence.*—For stations Needham Junction to Cook Street inclusive.

[1]*Mansfield.*—For Readville, Mass., and stations Roxbury to East Dedham inclusive, via either the West Roxbury or East Dedham Branches.

Boston.—For all other stations.

And so on for the entire road.

The following rules relate to the minimum:

148. Six thousand (6000) pounds has been established as the minimum for l.c.l. shipments for local stations and connections where not otherwise specified.

149. Note Exceptions: A four-thousand-pound (4000) minimum may be applied to l.c.l. shipments between stations wholly upon one division, or for a nearby station on a connecting division; this to avoid the delay and expense of handling to get the freight but a few miles beyond the transfer point. For example: Should Sharon Heights have 4000 lb. of freight for Norton, they would load in a straight car and card direct to Norton rather than to Mansfield Transfer. Should Wallingford have a shipment of 4000 lb. for West Haven,

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[1] When there is not required minimum for Mansfield or Providence, consolidate with New Haven freight.

they would load in a straight car and card direct to West Haven rather than to New Haven Transfer.

150. Ten thousand (10,000) pounds shall be the minimum on l.c.l. shipments East or North bound from Westchester Transfer, Maybrook Transfer and West Albany Transfer.

151. Eight thousand (8000) pounds shall be the minimum on l.c.l. shipments East or North bound moving from one transfer station to another transfer station except as above provided for Westchester, Maybrook and West Albany.

152. Stations from which way-freights start, and transfer or junction stations to which l.c.l. shipments are forwarded for consolidation, are authorized to forward peddler or way-cars with less than the 6000 lb. minimum, but must make but one light-weight car for any one train.

153. The minimum of 6000 lb. established for l.c.l. shipments will not apply to shipments of a perishable nature, the holding of which for the minimum would result in claim for damage. Agents should use their best judgment in loading and forwarding perishable freight.

154. Agents may disregard the minimum for l.c.l. freight and load a reasonable quantity, less than 6000 lb., destined to a point on a foreign line if an empty car home routed to that line is immediately available, but must use good judgment to avoid the unnecessary use of cars for small shipments.

155. Agents may disregard the minimum for l.c.l. freight and load a reasonable quantity less than 6000 lb. West or South bound to a point on this line, carding direct to destination, providing an empty car moving in that direction is immediately available, but must use good judgment to avoid detention of foreign cars.

156. Cars loaded to visible capacity with freight such as paper boxes, baskets, baby carriages and like articles not permitting minimum weight to be loaded may be handled as car load.

Following the l.c.l. instructions are "Instructions for routing c.l. freight to and from all stations—New York Division."

ROUTE CAR LOAD FREIGHT FROM STATIONS

Piers 45 and 50, New York.
Harlem River, N. Y., to Stamford, Conn.,
New Canaan, Conn., to Stamford, Conn.,
Woodlawn, N. Y., to Mount Vernon, N. Y.,
Western Connections via Harlem River, N. Y.
New York Central & Hudson River R. R. via Port Morris, N. Y.

FOR THE TERRITORY BELOW, AS FOLLOWS:

NEW YORK DIVISION

Via Direct Route.—For all stations and Western Connections via Harlem River.

SHORE LINE DIVISION

Via Direct Route.—For all stations except stations Saybrook Junction to Higganum which will route via New Haven and Saybrook Junction.

PROVIDENCE DIVISION

Via New Haven and Midway.—For all stations except Worcester, Mass., which will route from Midway via Putnam.

BOSTON DIVISION

Via New Haven, Providence, and Mansfield.—For all stations, except South Braintree, Braintree and stations to Cohasset and Pemberton, which will route from Midway via Attleboro and Taunton, and Needham and Upper Falls which will route from Midway via Providence and Franklin.

OLD COLONY DIVISION

Via New Haven, Midway, Putnam, and Worcester.—For stations Sterling Junction to Fitchburg.

Via New Haven, Midway, and Mansfield.—For stations Norton to Lowell; Farmingham to Marlboro and Clinton, and Canton to Stoughton.

Via New Haven, Midway, and Attleboro Junction.—For all other stations, etc., etc.

The whole is preceded by a general "Table of Contents" and a "List of Freight Stations." This list gives the names of stations alphabetically, state, and division on which located. Then follows a "Geographical list of stations," under which the stations are listed according to divisions and districts. To ascertain how a shipment should be handled, the instructions are looked up under the originating point; l.c.l. or c.l. as may be desired. This system replaced the "group system" a few years ago and has been found much simpler and more satisfactory.

For simplicity, elasticity and attainment of satisfactory results, the system inaugurated by Mr. C. H. Ewings on the New York Central, has superior merit. Every freight station, transfer station, and way-freight conductor is furnished with a set of loading orders showing the several straight and way-cars that are to be loaded daily or periodically, each order specifying how the car is to be carded, the time it is to be closed, the proper train connections, the minimum tonnage limit (when specified), and instructions in detail as to destination of freight to be loaded into each car. A sample form for this purpose is shown in Fig. 144.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD CO.

FREIGHT TRANSPORTATION DEPARTMENT

New York,............ ....

Taking Effect.................................. .....

Loading Order No............

For ....*Station.*

(Superseding Loading Order No.............

(Fig. 144.)

Agents must perform the loading of freight at their stations when less than car load lots in exact conformity hereto. No Modification of the arrangements here called for, nor any additional regular service, will be permitted except when covered by a subsequent order.

A loading order **modifying** *a previous loading order, affects only such cars as are mentioned by reference number on the modifying order; a loading order* **superseding** *a previous loading order, cancels the previous order and modifications entire.*

C. H. EWINGS,
Supt. Freight Transportation.

ABBREVIATION: W—way-car. S—straight car. D—daily. X—every two days.

Ref. No.	Straight or Way	Card	Closing Hour	To Take Train	Period of Loading	Tonnage Limit in Pounds	Load as Follows

Many of the larger stations have orders in this manner covering nearly 200 cars daily. Changes are not permitted in this arrangement except by authority of the superintendent of freight transportation, who issues a "modifying loading order" when found necessary, or desirable, which has the usual headings and using the same abbreviations, refers to the original loading order, specifying certain cars to be modified. It consists of the same number of columns and similar headings as the "loading order" which it is to modify. A "loading order" and a "modifying order" for the train instead of the station or transfer, is also provided with similar headings and abbreviations, but consists of six columns headed:

1. Reference number.
2. Straight or way.
3. From train.
4. To train.
5. Card.
6. Load as follows.

These are intended for way-freight trains. The original orders are printed in black; the modifying order in red.

The stations and transfer points make a daily report on a prescribed blank to the superintendent of freight transportation giving in horizontal lines the information under following column headings:

1. Reference number.
2. S. or W. (straight or way-car).

3. Car number.
4. Car initials.
5. Carded to destination.
6. Route.
7. Weight in pounds:
    (a) Car load.
    (b) Less than car load.
8. Schedule train.
9. Remarks.

It will be noted that this report shows both c.l. and l.c.l. and the reference number corresponds to that shown on loading order, as referring to l.c.l. cars. On the back of the form is a record of cars received loaded with less than 5000 lb., and complete instructions are contained on each blank.

The good feature of this report is that it enables prompt and intelligent checking of loading, and the value of such checking is recognized to the extent that the reports are actually checked, not with a view to fault-finding, but for the purpose of assisting the station forces in correcting errors and improving car loading. The co-operation of agents, conductors, trainmasters and others is secured, which insures the success of the system. The information as to l.c.l. tonnage from and to each point, is tabulated daily in blocks of five days, which are totaled and averaged, and at the end of the month a grand total is made for the month and average per car found. In this manner the unjust criticism of an occasional, or exceptional light load is avoided. The supt. freight transportation's office knows at all times whether the tonnage for straight cars is sufficient to warrant running them, or if the tonnage in way-cars averages very heavy. If the latter condition exists, an analysis of such way-cars is made and straight cars are established to certain points to save work and overtime of way-freights. If assigned cars to points on the line or beyond are running light, the traffic officers are conferred with and, usually, the straight car is discontinued and the freight loaded for transfer. The season of the year, the competitive traffic conditions, the increase or decrease of manufactured products, or other related factors, are taken into consideration in judging as to the weight permitted as a minimum. Superintendents, trainmasters, division freight agents, and commercial freight agents are encouraged to make recommendations as to the loading and movements, and meetings are held occasionally to consider possible changes for the benefit of the service.

The yardmaster's consist report is essentially the form ordinarily used for this purpose, giving the general heading showing direction of movements being reported—("Eastward")—train number, station, date, leaving time, engine number, conductor's name, followed by the specific information under column headings:

1. Cars:
   - (a) Initials.
   - (b) Number.
2. Contents. (E. if empty.)
3. From.
4. Slip-bill date.
5. Line.
6. Destination.
7. Preferred freight (mark "X")
8. Arrived:
   - (a) Date.
   - (b) Time.
9. Delay in hours.
10. Cause for delay.

This report is checked against the station report of cars loaded to see if cars go in the proper assigned trains. If the explanation for a delay or failure does not seem reasonable, further investigation follows. In this manner, a check is kept in the yard to see that cars are moved as arranged by the loading order, which specifies train in which car is to be forwarded.

The Delaware, Lackawanna & Western uses an admirable form for summarzing the results of the operation of its transfer platforms at Hoboken, Port Morris, Scranton, Binghamton and East Buffalo. The cost per ton runs from 30 cents at the smaller platforms to 22 cents at those with the greatest tonnage. The reports are reproduced in Figs. 145 and 146.

A recent magazine writer elaborated on our "intensive railroading." It may be questioned whether our methods are *progressive,* to say nothing of "intensive," until four things *at least* are changed and plans adopted whereby we may:

1. *Pool Freight Cars.*—Standardization of cars may bring about many advantages in addition to those claimed by the Master Car Builders, and the simplification of the pooling of cars and settlement for their use through a common clearing house. One advantage would be the ability to place cars on tracks alongside each other, at transfer stations and elsewhere, and match the doors without uncoupling or "spotting," thus rendering unnecessary the island platforms now utilized because cars are not of standard length. Increasing real estate values, as well as the cost of construction and maintenance of island platforms, make it desirable to avoid them. A large amount of switching of cars and of empty car mileage would also be obviated by pooling. Something has been said on this subject in Chapter IX.

THE DELAWARE, LACKAWANNA & WESTERN RAILROAD COMPANY

OFFICE OF GENERAL SUPERINTENDENT

OPERATION OF TRANSFER PLATFORMS AND COST PER TON

Stations	Year	Cars handled				Tonnage transferred									
		Cars placed at transfer		Cars taken from transfer		Car loads					Less car loads				
		Loaded cars	Empty cars	Loaded cars	Empty cars	Tons	Pay roll expense		Total	Cost per ton (cents)	Tons	Pay roll expense		Total	Cost per ton (cents)
							Foremen, checkers and others	Laborers				Foremen, checkers and others	Laborers		
Hoboken															
	Increase Decrease														
	Per cent.														
Port Morris															
	Increase Decrease														
	Per cent.														
Scranton															
	Increase Decrease														
	Per cent.														
Binghamton															
	Increase Decrease														
	Per cent.														
East Buffalo															
	Increase Decrease														
	Per cent.														
Total															
	Increase Decrease														
	Per cent.														

FIG. 145.

TOTAL PAY ROLL EXPENSE OF FOREMEN, CHECKERS, LABORERS AND OTHERS

Service performed	Year	Hoboken	Port Morris	Scranton	Binghamton	East Buffalo	Total
Transferring car loads							
	Increase Decrease						
	Per cent.						
Transferring less car loads							
	Increase Decrease						
	Per cent.						
Outside labor							
	Increase Decrease						
	Per cent.						
Total							
	Increase Decrease						
	Per cent.						
Rate per hour paid laborers							

FIG. 146.

THE DELAWARE, LACKAWANNA & WESTERN RAILROAD COMPANY

OFFICE OF GENERAL SUPERINTENDENT

OPERATION OF TRANSFER PLATFORMS AND COST PER TON

Stations	Year	Cars handled				Tonnage transferred									
		Cars placed at transfer		Cars taken from transfer		Car loads					Less car loads				
							Pay roll expense					Pay roll expense			
		Loaded cars	Empty cars	Loaded cars	Empty cars	Tons	Foremen, checkers and others	Laborers	Total	Cost per ton (cents)	Tons	Foremen, checkers and others	Laborers	Total	Cost per ton (cents)
Hoboken															
	Increase Decrease														
	Per cent.														
Port Morris															
	Increase Decrease														
	Per cent.														
Scranton															
	Increase Decrease														
	Per cent.														
Binghamton															
	Increase Decrease														
	Per cent.														
East Buffalo															
	Increase Decrease														
	Per cent.														
Total															
	Increase Decrease														
	Per cent.														

FIG. 145

TOTAL PAY ROLL EXPENSE OF FOREMEN, CHECKERS, LABORERS AND OTHERS

Service performed	Year	Hoboken	Port Morris	Scranton	Binghamton	East Buffalo	Total
Transferring car loads							
	Increase Decrease						
	Per cent.						
Transferring less car loads							
	Increase Decrease						
	Per cent.						
Outside labor							
	Increase Decrease						
	Per cent.						
Total							
	Increase Decrease						
	Per cent.						
Rate per hour paid laborers							

FIG. 146.

2. *Have complete consignment delivering data accompany each shipment.* Card bills accompany the car. They are meaningless and worthless beyond the mere piloting of the car to destination, and the side card often accomplishes this. The regular and full waybill, containing the information needed on which to deliver the freight, precedes or follows the shipment, and frequently misses the mark altogether. Cars are often placed for unloading and afterward displaced because the waybill is not at hand. It is not a business-like proceeding to do the physical part of the freight handling and then not deliver the freight to the awaiting consignee because the clerical part has been omitted or has miscarried. The receiving clerk at a freight-house should make triplicate or quadruplicate copies of billing, one copy of which should accompany the car in which the freight is forwarded. This may be elaborated sufficiently to have a copy of the original billing suffice for the final delivery expense bill handed the consignee. A suitable receptacle would have to be provided on the inside of every box car for this purpose. A car placed at the final destination platform may be opened and freight delivered, immediately after the wheels stop turning. Nothing short of this is consistent or logical.

3. *Handle freight on a piece-work basis at freight-houses and transfers.* This is already being done successfully at a number of points. The system is fully described elsewhere.

4. *Receive the package freight at and deliver it to the shipper's door in large cities.* This is the prevailing method in England and is fully described in Chapter XXI. It is also done in some cities in the United States and Canada, as explained in Chapter XXV. As land values in large centers increase and as freight business becomes heavier, it is essential that the handling of freight in houses shall be more rapid; and that the houses be used to move freight through and not to store it. When a company does its own teaming it increases its freight-house facilities. It is a very common experience to find teaming companies "lying by" on rainy days, or during ice and snow storms, when lighter loads have to be carried, or when they have an opportunity to obtain a few days' hauling at more remunerative rates. They argue that the outside contract may go to others while their railway work is always there for them to handle at their own convenience. The freight-houses, in the meantime, become congested.

CHAPTER XXIII

MECHANICAL HANDLING OF FREIGHT

The ordinary two-wheel truck is one of the most useful implements on railways. It has been used in some form since railways were first built and it seems destined to remain for a long time. It is at once a lever, turntable, conveyor and elevator. That it will be displaced by other methods where conditions are favorable, is just as certain as it is that the truck will be retained where it is better adapted to the purpose then any other method of moving package freight from one point to another.

Freight may be handled at houses or piers by:

1. Conveyors—roller, chain, belt, platform, etc.
2. Overhead traveling cranes.
3. Carrier systems.
4. Motor trucks.

Among the difficulties in the way of satisfactorily handling freight in ordinary houses are (1) the great variety in shape, size and weight of packages; (2) the necessity for receiving out-bound packages from teams at various points or doors; and (3) the necessity for moving in-bound freight from various cars to many points in the house.

In discussing the mechanical handling of freight, consideration must therefore be given to

(a) The utilization of all possible floor space for storage purposes.

(b) The transportation of freight from any point in the house to any other point in the house—which includes delivery to or on wagons at the doors—by mechanical means, rapidly and without interference.

(c) Handling of packages of various sizes, shapes and weights.

The means and methods of mechanically handling freight are so rapidly developing that anything said on the subject to-day may be antiquated to-morrow. Freight of one general class, such as flour in barrels, ordinarily moving from one point to another, may be handled satisfactorily and economically, on conveyors. For heavy moving on usual paths, as on water fronts, the overhead cranes or gantrys may be more advantageously used, although the most expensive to install, because of the necessity for heavy wall construction of houses and ample overhead clearance. Where the size, shape and weight of packages vary, the overhead monorail, or carrier system, with independent motors for lifting and propelling, is best adapted, but is also expensive and necessitates heavy wall construction and overhead clearance. Recently the motor truck, propelling itself on the floor of the house, usually with storage electric battery for power, has made surprising progress and promises a solution to the problem because of its adaptability to existing conditions, ease with which it may be transferred from one point to another, cheapness, great operating economy, and safety.

The conditions to be met may be more clearly understood and accurately represented by following the investigations and results of practical and experienced men. Mr. J. M. Barrett, formerly Supt. of Terminals of the Erie, gives the result of some interesting investigations:

"Our frontage (Duane Street station, New York) is 216 ft. We can back up 23 wagons at one time. The bulkhead is 50 ft. from the wagons to water's edge, with 5 openings to floats and barges. We tie up two barges and nine floats containing 90 cars. The freight begins coming very slowly from 7 a. m. and no freight is received unless the wagons are standing in line and the shipping bills punched at 4:30 p. m. One day on which we checked the handling of the outbound business, there was received:

Between	7:00 and 8:00	a. m.	27 wagons,
"	8:00 and 9:00	a. m.	51 wagons,
"	9:00 and 10:00	a. m.	64 wagons,
"	10:00 and 11:00	a. m.	75 wagons,
"	11:00 and 12:30	p. m.	79 wagons,
"	12:30 and 1:00	p. m.	32 wagons,
"	1:00 and 2:00	p. m.	77 wagons,
"	2:00 and 3:00	p. m.	85 wagons,
"	3:00 and 4:00	p. m.	116 wagons,
"	4:00 and 4:30	p. m.	142 wagons.

At 2:00 p. m. there were no wagons lined up waiting for berths: after 2:00 p. m., 343 wagon loads of freight were received to be handled, distributed and started from New York on floats at or before 5:30 p. m.; 748 wagons were received containing 648 tons; the average tonnage per wagon was 1732 lb. and average packages per wagon, 18: total number of packages 14,192, which required 5702 loads on hand trucks to take it from the wagons to the scales, and thence to the cars or barges. This freight was distributed into 86 cars or barges. The packages averaged 91 lb. per package and the load on each truck 228 lb. The average was two and one-half packages per truck. The shortest trucking distance from the wagons to the cars was 95 ft.; the longest 773 ft. Loading began at 9:20 a. m., stopped 30 minutes for lunch and finished loading at 5:30 p. m.; gang-planks and other utensils removed from the floats and barges at 5:45 p. m.

The average tonnage handled by each man trucking freight was 1736 lb. per hour or 6.7 tons during the actual working time. The number of truck loads handled by each trucker was 7.6 per hour, or 59 during the working time. The average distance each trucker traveled was 323 ft. plus the return distance with empty truck. It required to receive and check this freight from the wagons, 10 men for 93 hours; to weigh and check the freight from the scales to the cars

11 men 83 hours, with 11 men calling off freight at the scale houses. 46.1 per cent. of the total cost of handling the 648 tons represents the cost of the trucking only."

It will be readily understood that this condition is a difficult one to provide for by mechanical handling.

Mr. C. H. Stein, Engineer M. of W., of the Central of New Jersey, discussed the general question as follows:

"The problem at the railroad terminal is a complicated one. All the freight is in a chaotic condition. If it be at a terminal freight station it arrives from many points, and must be distributed from a number of cars to specified subdivisions in the freight-house, or to teams that may be waiting to receive it, but more frequently are not, and perhaps arrive just after it has been deposited at a storage point in the freight-house. If it be at a transfer station, then a few loaded cars placed in position must be transferred, the freight from them going in all directions to a large number of cars assigned to different destinations. In short, when the merchant or manufacturer receives his car-load consignments, everything has been reduced to an orderly condition, and may be handled in a systematic manner. On the other hand, the contents of the cars received at the freight terminal or transfer station are in a state of chaos and confusion. The very nature of the business compels this, and it remains for men made expert by experience to rearrange the shipments and restore them to an orderly state to accomplish the interests of security and promptness in delivery.

"Many forms of apparatus have been suggested, namely, platform conveyors, driven by roller, belt or chain; overhead traveling cranes, telpherage systems; combinations of telphers and traveling cranes. All of the various systems have such definite and conspicuous limitations that the immediate future does not offer us very much of a promising character. A machine, to be useful and economical, must be practical, have a wide range of action, and be completely under the control of the operator at high or low speed with light or heavy load. It must not be too cumbersome, and the track layout must be such as to permit a number of machines to operate without interfering with each other, going or returning. It must also be reliable and not easy to get out of order. It would be decidedly preferable for each machine to be an independent unit, thus avoiding the possibility of occasionally entailing idleness upon the entire establishment, and a resort to trucking because of the failure of some main part of the machine. I feel that the system of several traveling cranes with cross transpherers and electric hoists is open to this objection for freight-house or transfer station work.

Conceive of a transfer station that I have in mind where 32 cars are brought to a platform on each trip, and the contents distributed into 135 cars standing on nine tracks ready to receive them. The scene presented is that at times the truckmen are scattering in all directions to serve the various cars, and at others a great number of them are concentrating at a single car. With the large cumbersome traveling cranes, admirable machines in erecting shops and for various other purposes, the operation would be impossible. If any part should fail, it would tie up the entire station. It would not answer at all at a transfer. Its efficiency would be greater at a freight terminal, but even there it has its demerits, notwithstanding the application of the gliding and expanding switches. A machine to be considered worthy of consideration would have to accomplish everything that is now performed by hand trucks, and manual labor, at such a rate of speed as to take care of the rapid increase in terminal and transfer business, and return a reasonable interest on the investment, based upon the original installation, changes made in station structure, depreciation of the machinery, maintenance, cost of operation, etc. Otherwise stated, the investment made would have to increase the capacity of the station, and every dollar spent in operation would have to have so much greater earning capacity as to pay the fixed and incidental charges and return a reasonable percentage on the investment.

The present style of construction of our transfer and terminal stations is not adapted to the installation of conveying machinery, except in a few instances. It would thus become necessary to make a large expenditure to provide for such installations. In many cases this would be prohibitive. It behooves us, however, to bear this in mind in the construction of all new buildings, so proper provision in regard to strength and head-room may be made, based upon possible future developments. The device of the future will have to be such that it can operate over the entire floor area, store the freight to a reasonable height, and remove same again quickly, delivering to car or wagon. In the case of pier sheds it would be necessary to deliver to cars, wagons or lighters. At inbound and outbound freight-houses delivery would have to be made through or around the freight-house between cars and wagons. At transfer stations, cars standing to a large number on many adjacent tracks would have to be reached, and movements of loads should not interfere with each other.

"The spacing of tracks at many of our transfer stations would not permit of lowering the freight between cars. This would result in the necessity of spreading tracks. In many cases the car storage room is already scarce and insufficient, preventing track spreading. It might, therefore, eventually, in the line of progress, call for the co-operation of the equipment designers to provide freight cars with roof hatches at least as large as a car door and preferably larger. Some provision will be necessary for weighing shipments, which must be done accurately and quickly, without interfering with other movements of freight. Suspended scales would have to be located at points within easy reach from all parts of the building and in the lines of least resistance."

The conveyor system is the simplest but is not adaptable to changing conditions. At a transfer station it may be necessary to take the contents of one car, often in small loads, into any of 200 cars or from any of the 200 cars into one car, and there would be nearly 20,000 separate paths or courses for the trucks, and yet this problem can be easily solved by the use of the electric carrier and movable by-path track. Although the action of these electric carriers and trailers is almost continuous, yet each train being independent, an accident to one does not stop operation for a minute.

There is still another type of machinery for handling freight between variable points, the movable platform, which is used in two ways, (a) to move the freight itself when loaded on the movable platform and (b) to move the trucks on which the freight is loaded. Both methods reduce the time and labor involved in moving the freight by hand over long distances. A traveling platform level with the floor has been devised, moving at slow speed, so that men, trucks and teams can cross it. As proposed for an inbound freight-house of the Baltimore & Ohio, the moving platform would form a belt line; one side would be near the track side and the other near the team delivery side. Packages, or trucks, from the cars would be dropped on the moving platform. The house would be divided into sections, with a man to each, and each man would pull from the platform the freight for his section as it passed him. In another system, the platform would be a single line only, the return side being underground. This was designed more particularly for steamship piers, where freight delivered at the end or from a ship has to be transferred for a considerable part of the length of the pier.

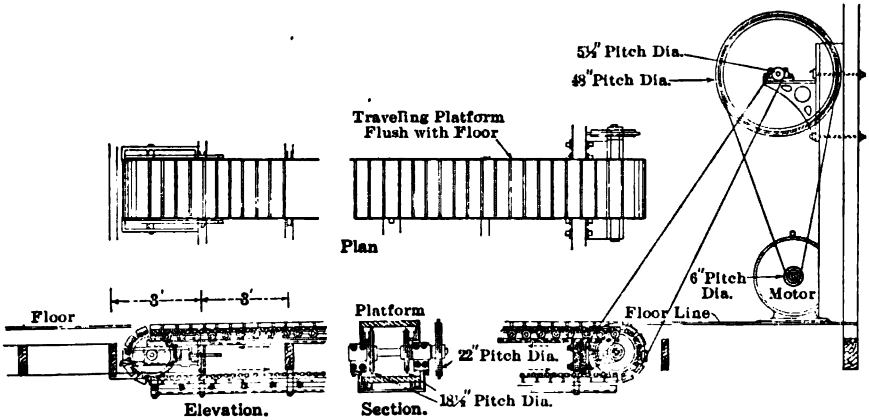

FIG. 147.—Traveling platform for freight handling.

A system of handling freight trucks by a traveling chain has been patented by a firm of conveyor manufactures, and is intended to reduce the labor of the trucking in a longitudinal direction. The idea was to devise a system that would provide for taking freight from any car along the platform and delivering it to any other car, as conditions required. In order to accomplish this it was found desirable to use the ordinary hand-truck, with slight modifications, so that it can readily be wheeled around from one place to another by manual labor when desired. The truck travels upon a narrow-gage track, and is provided with special attachments to engage an endless chain set underneath the track. This driving chain lies entirely beneath the floor, and is out of the way. As there is only a groove 1 inch wide in the floor there is no danger of accidents and the floor is left entirely free to truck across or walk upon at any time. An elevation plan and other details of a moving platform are shown on Fig. 147.

Mechanical freight handlers, or conveyors, are in use for loading and unloading vessels at Northern Steamship Co's wharf, Buffalo, adjustable to height of tide and freeboard of vessel. Four continuous carriers, also adjustable, are used by Southern Pacific at New Orleans and 28 at Galveston. A saving of $48 per day was effected at New Orleans, which paid for the conveyors in a year—and in 7 years repairs and maintenance did not exceed $500. A carrier, designed to handle tierces, barrels and sacks between a sugar refinery and shipping wharf at Chicago, 435 ft. long, with adjustable end, having a rise and fall of 16 ft., handles 75 barrels of 700 lb. each, and will easily transfer 6000 barrels in 10 hours. An endless carrier, 95 ft. long, 4 ft. wide, adjustable height, loads and unloads vessels of Texas & Pacific at Donaldsonville, La. The New Orleans & Western has a carrier at Port Chalmette, La., operated by electric motor, with a capacity of 500 bales cotton per hour. A similar carrier is in service at Butler Bros. warehouse, St. Louis, length 132 ft. The Anchor Line has a freight conveyor at Chicago, arranged to handle freight direct or on trucks, for the purpose of eliminating the services of six or eight men who pushed loaded trucks from steamer up a steep incline to the first floor of the warehouse. At Sydney, N. S. W., five inclined conveyors receive wheat in bags from cars, elevate and deliver it to a series of longitudinal conveyors which, in turn distribute the bags to piles and also deliver it from the piles to automatic ship loaders. These automatic loaders, four in number, receive wheat from the longitudinal conveyors and deliver it to holds of vessels. The capacity of the plant is 3600 bags per hour. The Boston & Maine has at Charlestown, Mass., nine freight elevators—three in each warehouse—5 ft. × 8 ft. platform, electric motor driven, with a capacity of 2000 lb. on each.

Overhead cranes and gantrys are serviceable when heavy, bulky commodoties are handled over constant routes and with slight variations in distances. Portable gantry cranes are used on the Hamburg docks—the best in Germany—which hoist the cargo from the hold of the vessel, swing the load through a section of a circle of 180 degrees and deposit it upon cars beneath the crane or upon car tracks between the crane and the shed, or upon drays, or upon platform of the shed or warehouse. In contrast, in loading a ship at Galveston, the freight is trucked by hand to the inclined board and then hoisted by the ship's derrick. At the Kuhwaeder Dock, Hamburg, 134 portable gantry cranes are in use.

The average cost of unloading and swinging upon the dock varies from 2 to 3 cents per ton and English figures are given at less than 1 cent per ton. This includes all expenses and depreciation of the machinery. The power used is almost always electricity, and the cost of electricity is about fifteen one-hundredths of a cent per ton at 2 cents per kilowatt-hour. These figures vary somewhat, depending upon local conditions and the cost of the electric current, which varies at European ports from 2 to 8 cents per kilowatt-hour.

In some cases it is stated that as many as 40 movements have been performed within an hour, that is to say, 40 complete cycles. A complete crane cycle, often mentioned in German figures, consists in hoisting the load 50 ft., slewing 150 ft., lowering to the platform, raising, slewing back and lowering the hook to the starting point. Twenty cycles per hour can easily be accomplished. The number of cycles depends largely upon the operator.

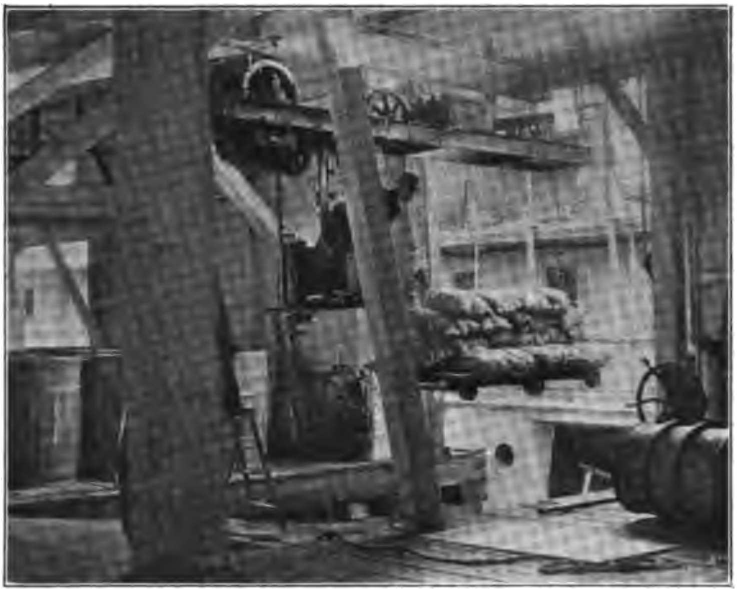

FIG. 148.—Carrier system, Richmond, Va.—Old Dominion Steamship Co.

Carrier systems are becoming more numerous and in their development many of the difficult features are being overcome. Many concerns are now manufacturing them; some are prepared to install them in large houses, guaranteeing a saving in the cost of handling that will pay the entire installation cost in from 1 to 2 years, depending on amount and kind of freight to be handled and difficulties in construction.

It has been asserted that certain prominent manufacturing companies would agree to furnish overhead electrical appliances, which would transfer freight 1500 ft. at a cost of 5 cents per ton for that portion of the work which is now costing more than 25 cents.

English figures condensed from an article in the "London Electrician," September 13, 1907, are given at less than 0.5 cents per ton for discharging 1000 tons general cargo, with cranes of 3 tons capacity, this being the total expense of crane work.

An overhead runway system is in use at a steamship pier, and is to be used by the Baltimore and Ohio. A pair of trolleys riding on an elevated runway carry a frame with hoists for raising and lowering trucks or wheeled platforms. Current for electric traction is taken from an overhead wire, and an attendant riding with the machine controls the traveling and hoisting movements. This system has been in operation for about 4 years on the pier of the Old Dominion Steamship Company, at Richmond, Va. It handles 3-ton loads between the wharf and the railway warehouse and cars. Two views are shown in Figs. 148 and 149; in one the hoist is seen elevating a load of 3.5 tons of sugar from the port of a steamship which the telpher conveys a distance of 500 to 600 ft. to the warehouse; in the other view truck loads of bags in transit are seen, moving from warehouse for unloading alongside of cars. It is said to show a great saving in cost over the old hand-truck method, besides being able to handle freight more rapidly and with much greater ease. One operator does the work formerly requiring the services of 16 men.

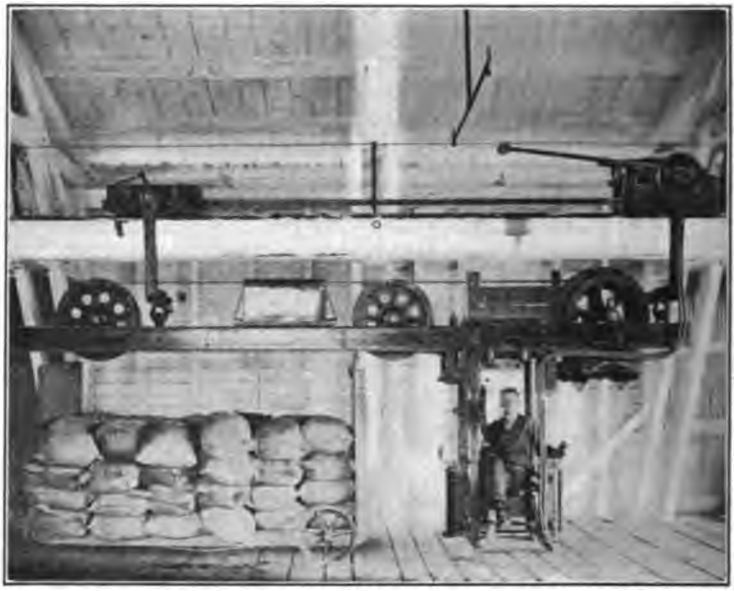

FIG. 149.—Carrier system, Richmond, Va.—Old Dominion Steamship Co.

A telpherage installation has been designed for the Bergen freighthouse of the Erie Railroad. Sectional and detailed views are shown

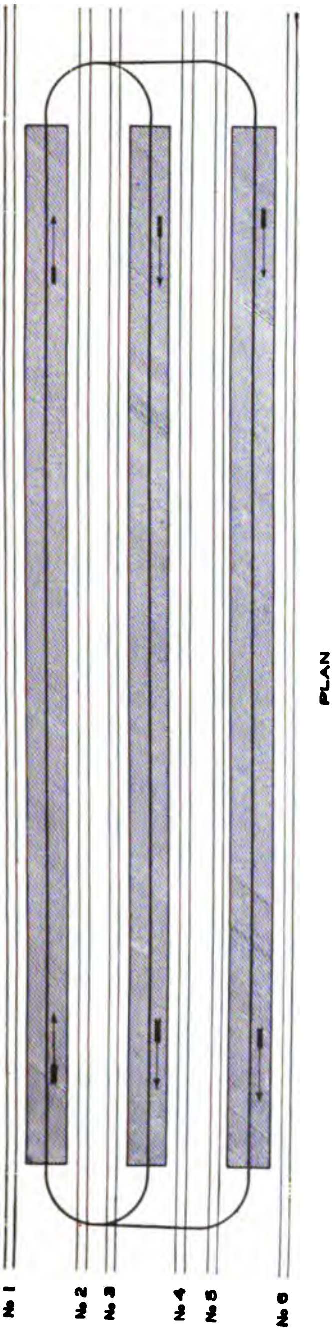

FIG. 150.—Plan of carrier system at Bergen, N. J.—Erie Railroad.

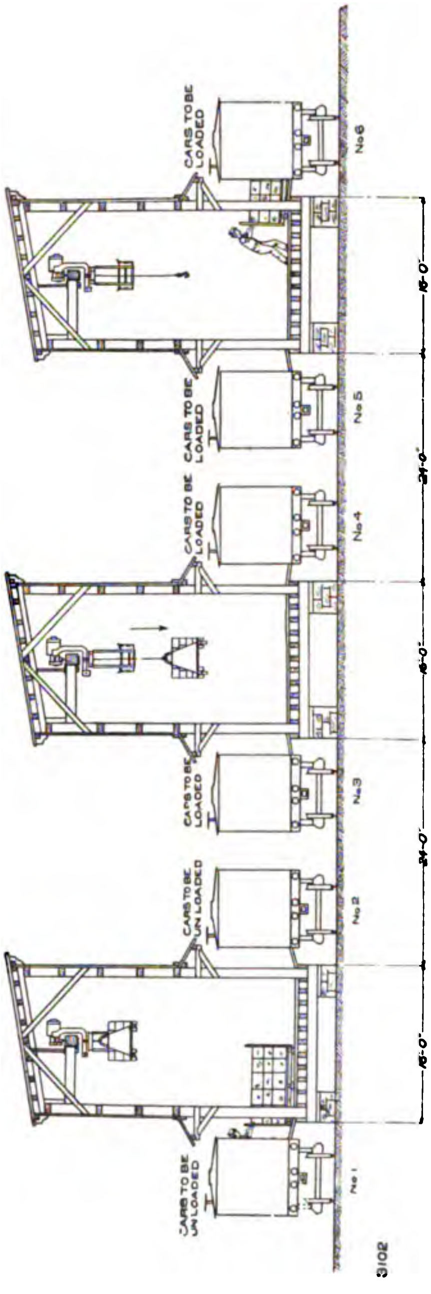

FIG. 151.—Sectional view of carrier system at Bergen, N. J.—Erie Railroad.

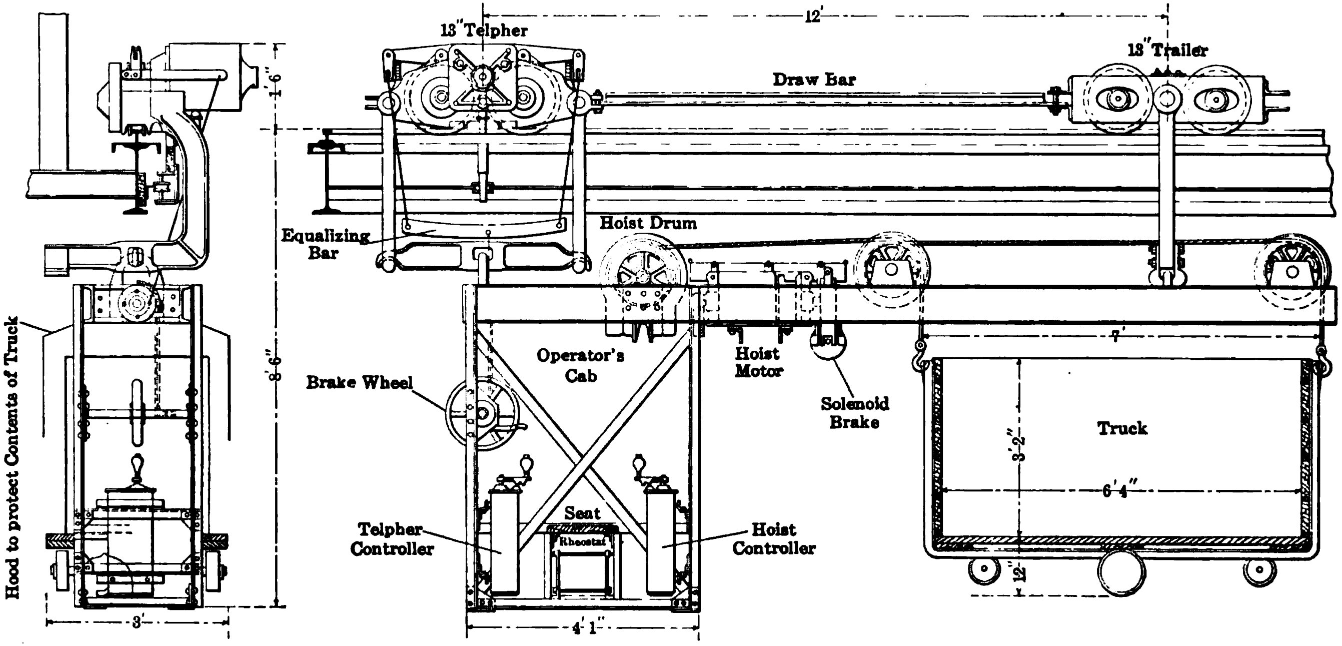

Fig. 152.—Details of carrier system at Bergen, N. J.—Erie Railroad.

in Figs. 150, 151 and 152. This house has three platforms, each 1400 ft. long, and three telpher tracks (one over the center of each platform) connected by loops at the ends. Ten telpher machines operating at one time on the three tracks, all machines following each other in the same direction around the loop, would provide for a movement of 1000 tons of freight per day of 20 hours. Each machine is expected to make one round trip of 3000 ft. in 6 minutes, at the rate of 10 trips per hour. The average speed would be 500 ft. per minute, including all stops and slowdowns, and the maximum speed of traveling 1500 ft. per minute.

The cost of handling freight in the above manner has been figured at 5 cents per ton. This is based on carrying an average load of only 1000 lb. at each trip, although the machines are to have a maximum capacity of 2000 lb., which seems sufficient to handle the bulk of the freight. This cost per ton is also based on electric power supplied at 4 cents per kilowatt-hour, and a telpher rider at 20 cents per hour. This does not include the labor for loading the freight onto the trucks and placing them beneath the telpher runway, nor for unloading the trucks and replacing them under the runway.

The Memphis Warehouse Co. has overhead trolley tracks (Breck system) for handling cotton. The trolleys are not motor-driven, but the tracks have a slight grade so that the load moves by gravity. The grade begins at the beginning of the inbound platform and extends through the plant to the end of the outbound platform, a distance of about 1.25 miles. The arrangement permits of placing four—or even six—trains of 25 cars each at the inbound platforms at one time, without "spotting." This makes it possible for one yard engine and crew to do the work, while ordinarily three or four engines would be required. There are about 3 miles of the trolley runway and 6 miles of railway tracks. The cost of handling by the telpherage system is said to be only about one-eighth of the cost of teaming. The company has an extensive cotton warehouse and compress plant, with storage capacity under cover for about 125,000 bales.

The latest development of the overhead trolley system, in an effort to reduce terminal costs, congestion and time of handling l.c.l. freight is the installation in the double-deck St. Louis freight-house of the Missouri, Kansas and Texas Terminal Co.

The ground floor is given over to cars and the one above to the receipt, delivery and storage of freight. Connection and transfer between the two floors and any point of the building are made by a telpherage system having monorail runways across the line of the tracks and suspended from the second floor ceiling over hatchways leading to the lower floor. Transferring from one runway to another is done over leads at each side of the house. Telphers enter and leave the leads by means of automatic electric track switches. Seventy-five per cent. of the l.c.l. freight handled is outbound, and the design has been worked out to provide a capacity of 1,000,000 lb. in 5 hours. The present installation provides for the loading of 77 cars, and is arranged for easy expansion. Freight of a very diversified character is handled at this terminal, including all the classifications and varieties of packages usually found in shipments to and from a large city.

This freight station is a two-story structural steel building having brick walls and reinforced concrete floors. It is 232.5×403 ft. in plan, and, with the 16 tracks, automobile shed and incoming switch tracks, occupies two and one-half city blocks.

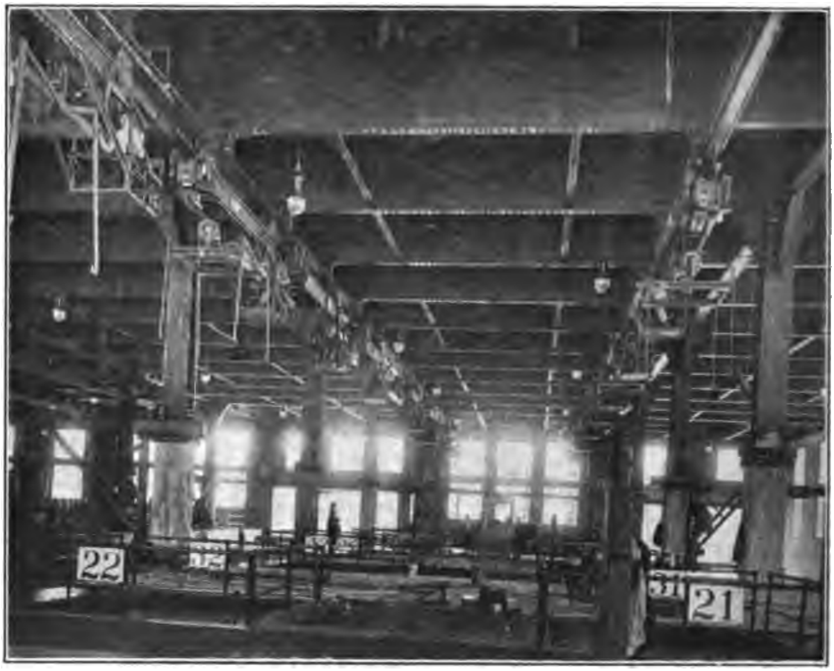

FIG. 153.—Telphers on runways above hatches, St. Louis Terminal—Missouri, Kansas & Texas.

On the ground or track floor the building is enclosed only on two street sides. Twelve stub tracks ending at Mullanphy Street enter from the open north end by a ladder system having four branches. Each track has a capacity of nine freight cars, but under normal conditions receives only eight. The tracks are spaced in pairs opposite 11.25 ft. island platforms between columns supporting the building. Trucking through the cars is thus eliminated and the column spacing of 38.25 ft. definitely fixed. The platforms are wide enough to permit two trucks to pass conveniently. Very little longitudinal trucking is anticipated, as transferring from car to car will be done by the telphers up through the hatchways and down to the receiving car, which may be in any part of the building. The 4800 ft. of trackage under cover provides for 117 cars. Four team tracks to the east of the building for both in- and outbound freight have a total capacity of 60 cars, 20 of which are served by a moving 12-ton gantry crane having a travel of 400 ft. These tracks are used to a large extent for shipments of heavy machinery and other bulky freight requiring an entire car for one or several pieces.

An interior view of the telphers on runways above hatches is shown in Fig. 153; the interior of team floor in Fig. 154, from which the arrangement of the hatchways in the platform over the train platform of the lower floor is clearly indicated. The small piles of freight are loaded on wheeled platforms which are picked up by the telphers. Several runways are shown; at the left of the view in Fig. 154 one of the switches may be seen connecting the longitudinal with the transverse runways.

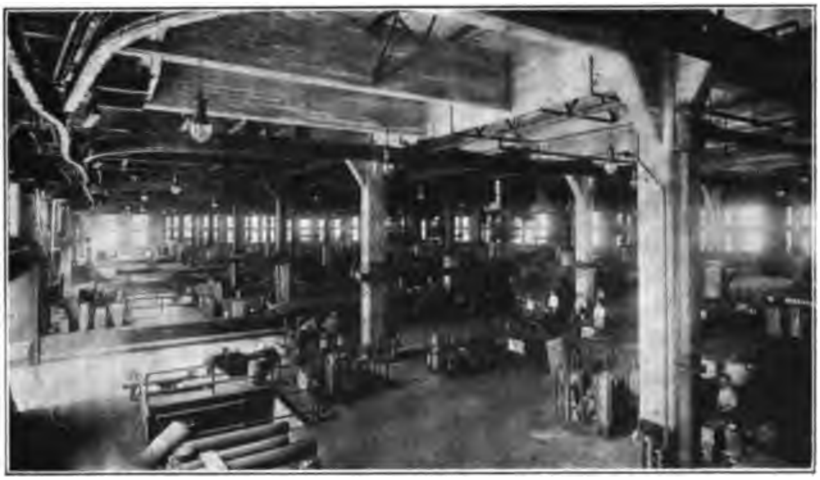

FIG. 154.—Interior of team floor, St. Louis Terminal—Missouri, Kansas & Texas.

On the second floor there are four driveways 38 ft. wide, extending across the width of the house. Adjacent to the driveways are four platforms, two wide ones, 82×230 ft. providing storage for inbound freight as well as for receiving outbound, and two narrow platforms, 42×217 ft. primarily for outbound freight. Driveways extend around the inside ends of the narrow platforms to facilitate the movement of drays.

Telpher runways pass longitudinally above the wagon platforms or in the direction across the tracks of the lower level, two runways being suspended over each of the two narrow platforms and one of the wide ones, and four runways over the remaining wide platform. Each of these runways connects with lead tracks at the two sides of the building. Hatchways through the wagon platforms are provided below the runways over each car platform in the lower level so that there is a hatchway for every two cars.

Numerous experiments, observations and measurements have been made to determine unit movements by the old system of hand trucking. The methods successfully tried out are being adapted to the new conditions. Some of the results are given below. The 1600-ft. total length of platforms which is available to handle the 500 tons of freight in 5 hours, the capacity for which the station is designed, is more than double the length heretofore used. The driveways are placed the short way of the building, as it has been observed that short driveways do not become so congested as long ones. A width of driveway has been well established elsewhere at 38 ft. but was checked up in St. Louis by numerous measurements of drays both as to width and length. The unit movements ascertained by the new system are very uniform:

Average number of truck loads handled per day by each man, 157.
Average pounds on each truck, 225.
Average tonnage loaded in each car, 8 tons.
Average number of cubic feet in each car, 288.
Average time weighing a truck load on beam scales, 30 seconds.
Average time weighing a truck load on automatic scales, 10 seconds.
Average length of teams and drays, 18 ft.
Average width of drays, 6 ft. 3 in.
Maximum width of drays, 8 ft. 6 in.; minimium, 5 ft.
These averages are based on a total of 1,000,000 lb. freight handled.

The method advocated by several railway operating officers as being the most practical for handling the small freight, is by providing stoutly constructed portable platforms of convenient size, having chains attached to the four corners, which could be swung from the hook of the crane. Several of these could be placed conveniently near the door where a car was being unloaded and the freight deposited directly upon them by men who were breaking out the car. The platforms could then be handled either by the trolley hoist or the traveling crane, or both, and set down at any spot in the freight-house where it might be desired to place them for storage, or (platform and all) placed directly on the wagon waiting to receive them. The size of the platforms could be made to conform as nearly as practicable to the average size of the ordinary transfer truck or wagon. It could be so designed as to allow for the mechanical handling of freight along the lines indicated and with rapidity and economy of operation which should reduce by at least 50 per cent. and probably more, the expense that is now incurred in the ordinary inbound house, where the freight is handled entirely by hand. This same idea could be enlarged and elaborated upon in connection with combined freight and storage houses, where it is desirable to utilize two or three floors of the building.

The motor truck is the youngest member of the mechanical freight handler's family but possibly the most promising. It is a development and an adaptation of the power trucks used in the new Grand Central and Pennsylvania passenger terminals at New York and elsewhere for handling baggage.

A very thorough test has been given the motor trucks by the Erie at Jersey City where 20 storage battery vehicles are in use, and reduced the freight handling force from about 80 to something like 30 men. The truck in use there has 50-in. wheel bases —36-in. gage—four wheels, 16-in. diameter. Unlike the baggage trucks it is controlled from one end only and is steered by the wheels at one end, the well-known feature of the rear wheels on the baggage trucks turning in the opposite direction from the front wheels, being omitted. The Erie ordinarily uses 14 trucks as a maximum, handling 45 cars of transfer freight on floats and 75 to 85 outbound car loads daily, ranging from 600 to 800 tons. The following is a tabulation of the results of the work of these power trucks at that point:

COST OF HANDLING FREIGHT AT DOCK 6, JERSEY CITY TRANSFER, ERIE RAILROAD

Comparison of the cost during period that storage battery trucks were in use, with same period the year previous.

With storage battery trucks				With hand trucks			
Month, 1911	Tons	Cost	Cost per ton	Month, 1910	Tons	Cost	Cost per ton
April	13,640	$4,418.88	.324	April	15,252	$6,015.97	.394
May	13,829	4,165.11	.301	May	14,872	5,727.07	.387
June	14,382	4,128.39	.287	June	15,812	5,979.77	.378
July	13,517	3,888.05	.286	July	15,083	5,801.88	.385
Aug	14,426	4,129.29	.286	Aug	16,102	6,190.32	.384
Sept	14,877	4,191.73	.282	Sept	16,041	6,289.75	.392
Oct	15,095	4,305.72	.285	Oct	16,956	6,615.10	.390
Nov	14,312	4,268.99	.298	Nov	15,506	6,142.03	.396
Dec	13,000	3,934.10	.303	Dec	14,786	5,896.44	.399
Total	127,078	$37,410.35	.294	Total	140,410	$54,658.33	.389
Decrease	13,332	17,247.98	.095				

NOTE.—The above cost in 1911 with storage battery trucks, includes running repairs, viz., material, current and electricians.

The electric storage battery trucks were installed at Dock 6 in the month of April, 1911, 20 of them being purchased for this purpose. The cost of handling freight at that point for some years previous, is given below. Freight-handlers' wages from 1903 to 1909 were at the rate of .185 per hour, in 1901–10, .155 per hour, and in May, 1910, increased to .175 per hour, most of them, however, getting .17 per hour.

COST OF HANDLING FREIGHT AT DOCK 6

Fiscal year	Tons handled	Total cost	Cost per ton
1903–4	151,626	$72,024.60	.475
1904–5	147,274	66,095.96	.448
1905–6	143,277	64,621.35	.451
1906–7	150,930	70,881.35	.47
1907–8	143,239	65,559.04	.458
1908–9	145,832	55,372.64	.38
1909–10	171,983	62,697.83	.365
(1st 9 mos.) 1910–11	137,435	53,618.43	.39

The greater part of the freight is handled between 6 p. m. and 10 p. m. The truck controller is arranged for five speeds—the maximum about 10 miles per hour which is ordinarily used. The trucks attain this speed quickly and may be stopped in a very short space. They are run through the cars and into the ends of cars, being backed out by reversing instead of attempting to turn. The cost of handling freight has been reduced 30 to 35 per cent.

On pages 344, 345, 346 and 347 are tabulations of an exhaustive series of experiments with an electric motor, storage battery, freight truck at the Providence, R. I., freight transfer platforms, outbound houses, inbound houses and steamship piers; respectively. The figures indicating general results are tabulated and require little explanation. This particular truck was tested on a carefully measured incline of 15 per cent. ascending grade, and by loading with pig iron, gradually increasing the load; it demonstrated its ability to ascend the grade with 6750 lb. load, and stopped and started with that weight of load. A general view of

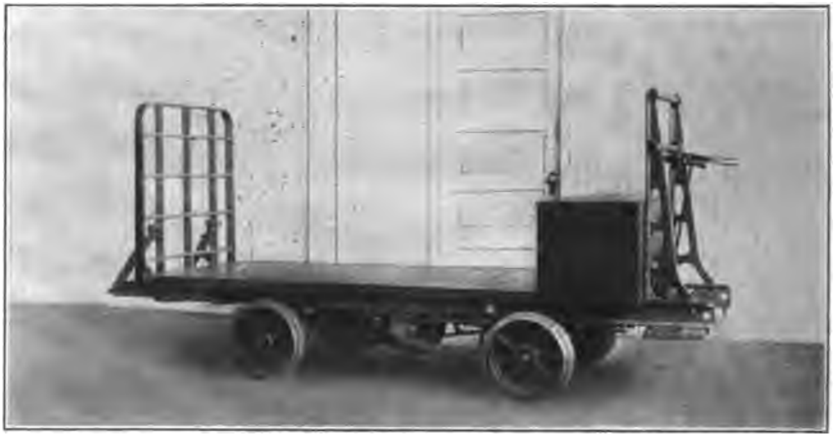

FIG. 155.—Electric motor, storage battery freight truck.

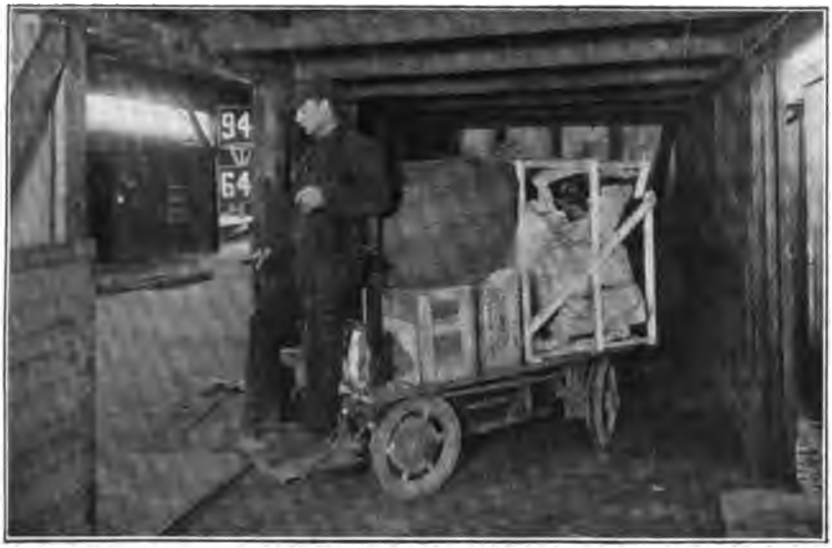

FIG. 156.—Electric freight truck, loaded, inside a box car.

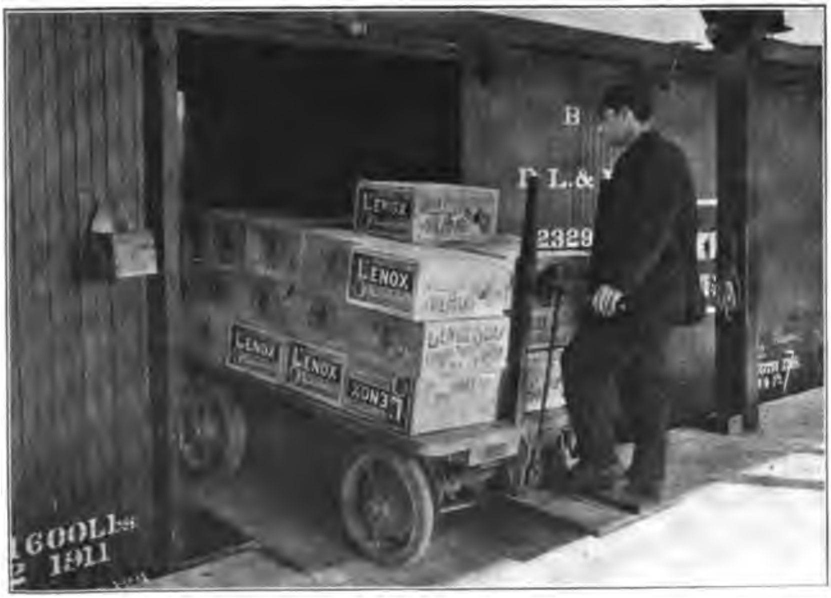

FIG. 157.—Electric freight truck entering a box car.

PERFORMANCE OF ELECTRIC FREIGHT TRUCK AT PROVIDENCE TRANSFER PLATFORMS

1912	Hours in service	Distance (feet)	Weight (lb.)	Average tons per hour	Number of loads	Average length of haul (feet)	Average number of pieces per load	Average weight per piece in pounds	Average weight per load in pounds	Total number of pieces	Maximum load (pounds)	Average minutes running per load	Average time to load (minutes)	Total hours loading and unloading	Total hours running	Number of men in gang	Wages of men	Cost of labor per ton including checking clerk	Wages not including checking clerk	Cost of labor per ton not including checking clerk
Jan. 2......	6.43	9,630	34,467	2.68	27	357	13.8	92.6	1,276	372	3,020	4.60	5.70	4.33	2.10	4	4.62	26.808	3.16	18.336
Jan. 3......	7.90	20,980	43,351	2.74	37	567	10.3	113.8	1,172	380	3,600	4.30	4.10	5.22	2.68	4	5.38	24.821	3.68	16.978
Jan. 4......	7.78	15,905	45,348	2.91	32	497	12.3	115.4	1,417	396	3,370	4.40	6.70	5.45	2.33	4	5.33	23.507	3.65	16.098
Jan. 5......	5.72	12,435	32,244	2.82	26	478	12.8	96.2	1,240	335	3,275	5.10	4.40	3.50	2.22	4	3.86	23.942	2.64	16.375
Jan. 6......	6.63	13,360	46,772	3.53	36	371	13.0	99.9	1,299	469	3,770	3.90	4.60	4.25	2.38	4	4.54	19.413	3.10	13.256
Jan. 8......	7.03	17,020	51,840	3.69	40	425	8.0	160.0	1,296	322	3,035	4.30	4.50	4.18	2.85	4	5.01	19.328	3.43	13.233
Jan. 9......	8.37	18,240	36,210	2.16	38	480	11.6	82.2	953	441	3,150	4.10	6.50	5.75	2.62	3	4.56	25.186	2.71	14.968
Jan. 11......	4.23	9,730	27,424	3.24	17	572	23.8	67.8	1,613	404	3,329	5.60	6.60	2.65	1.58	4	2.91	21.222	1.98	14.443
Jan. 12......	7.05	12,300	32,086	2.28	31	397	20.9	49.5	1,035	647	3,128	4.80	6.10	4.57	2.48	3	3.82	23.811	2.24	13.962
Jan. 16......	6.70	8,975	35,650	2.66	30	299	10.1	117.6	1,188	304	4,500	3.60	7.30	4.90	1.80	3	3.65	20.476	2.14	12.006
Jan. 18......	7.60	13,280	31,931	2.20	30	442	8.66	122.9	1,064	260	2,605	4.60	7.10	5.28	2.32	3	4.13	25.869	2.42	15.158
Jan. 19......	6.77	9,975	38,644	2.85	30	332	20.9	61.6	1,288	626	3,000	4.03	5.35	4.73	2.03	3	3.66	18.942	2.14	11.075
Jan. 20......	7.82	14,100	45,989	3.07	28	503	16.6	98.9	1,642	466	3,075	4.50	8.25	5.72	2.10	3	4.23	18.395	2.48	10.784
Totals......	87.37	175,930	501,956	2.87	402	438	13.5	92.4	1,248	5,419	4,500	4.40	5.90	60.53	29.50	3 & 4	55.70	22.191	35.77	14.251

PERFORMANCE OF ELECTRIC FREIGHT TRUCK AT PROVIDENCE OUTBOUND HOUSE

1912	Hours in service	Distance (feet)	Weight (lb.)	Average tons per hour	Number of loads	Average length of haul (feet)	Average number of pieces per load	Average weight per piece in pounds	Average weight per load in pounds	Total number of pieces	Maximum load (pounds)	Average minutes running per load	Average time to load (minutes)	Total hours loading and unloading	Total hours running	Number of men in gang	Wages of men	Cost of labor per ton including checking clerk	Wages not including checking clerk	Cost of labor per ton not including checking clerk
Jan. 23......	8.76	7,610	66,731	3.80	52	146	12.2	105.2	1,283	635	5,100	2.90	4.10	6.27	2.50	3	4.75	14.236	2.78	8.332
Jan. 24......	7.65	11,335	64,285	4.20	43	264	13.8	108.3	1,495	593	3,000	3.90	3.50	4.87	2.78	3	5.52	12.880	3.80	11.822
Jan. 25......	8.83	4,620	56,312	3.17	44	105	19.2	67.0	1,279	843	3,970	2.60	5.80	6.90	1.93	3	4.79	17.016	2.80	9.944
Jan. 26......	8.80	5,110	46,432	2.64	46	111	12.3	82.0	1,009	564	2,063	3.10	4.70	6.38	2.42	3	4.78	20.589	2.80	12.061
Jan. 27......	9.13	4,420	63,051	3.45	47	94	14.0	95.8	1,341	659	4,840	2.70	5.60	7.03	2.10	3	4.95	15.702	2.90	9.199
Jan. 30......	8.53	4,100	47,185	2.77	42	98	17.4	64.5	1,123	732	3,315	2.50	6.00	6.90	1.63	3	4.61	19.541	2.70	11.444
Jan. 31......	9.28	6,090	47,137	2.54	45	135	18.8	55.7	1,047	846	2,960	2.40	5.70	7.32	1.97	3	5.05	21.431	2.96	12.559
Feb. 1.......	8.97	4,330	52,282	2.93	47	92	11.6	95.9	1,112	547	3,125	2.40	5.40	7.10	1.87	3	4.84	18.515	2.84	10.864
Feb. 2.......	8.85	4,390	43,255	2.44	41	107	15.7	67.0	1,055	645	2,872	2.60	6.00	7.05	1.80	3	4.78	22.101	2.80	12.947
Feb. 3.......	8.77	4,790	54,347	3.10	47	102	14.5	79.8	1,156	680	3,496	2.90	4.30	6.45	2.32	3	4.78	17.590	2.80	10.304
Feb. 6.......	8.95	6,690	49,106	2.74	40	167	17.6	69.4	1,221	705	3,000	2.67	6.05	7.17	1.78	3	4.86	19.794	2.84	11.567
Feb. 7.......	8.65	3,830	40,586	2.34	33	116	19.3	64.2	1,230	637	2,303	2.17	7.33	7.45	1.20	3	4.71	23.210	2.76	13.600
Totals.......	105.17	67,315	630,709	3.00	527	128	15.4	77.7	1,197	8,086	5,100	2.70	4.57	80.88	24.30	3	58.42	18.523	34.78	11.024

PERFORMANCE OF ELECTRIC FREIGHT TRUCK AT PROVIDENCE INBOUND HOUSE

1912	Hours in service	Distance (ft.)	Weight (lb.)	Average tons per hour	No. of loads	Average length of haul (ft.)	Average number of pieces per load	Average weight per piece in pounds	Average weight per load in pounds	Total number of pieces	Maximum load (pounds)	Average minutes and seconds running per load	Average time to load (minutes)	Total hours loading and unloading	Total hours and minutes running	Number of men in gang	Wages of men	Cost of labor per ton including checking clerk	Wages not including checking clerk	Cost of labor per ton not including checking clerk
Feb. 8......	9.00	10,990	39,669	2.20	43	256	12.0	76.8	922	518	2,010	3.20	5.70	6.71	2.28	3	4.89	24.655	2.86	14.420
Feb. 9......	9.80	9,900	39,399	2.01	39	254	21.3	47.4	1,010	832	1,860	3.60	6.60	7.41	2.38	3	5.33	27.056	3.12	15.832
Feb. 10......	7.33	8,250	54,079	3.69	38	217	10.5	135.5	1,423	399	3,020	3.20	8.30	5.27	2.07	3	4.12	15.237	2.48	9.172
Feb. 13......	10.18	1,1830	54,650	2.68	43	275	14.6	87.1	1,271	626	2,642	3.90	10.30	7.40	2.78	3	5.65	20.677	3.35	12.259
Feb. 14......	9.03	8,950	48,820	2.70	39	229	16.7	75.0	1,252	650	3,710	3.20	6.30	6.95	2.08	3	4.99	20.442	2.96	12.126
Feb. 15......	10.25	12,600	60,779	2.96	50	252	13.8	88.0	1,215	690	2,600	2.53	5.55	8.14	2.12	3	5.67	18.658	3.37	11.088
Feb 16......	10.98	13,210	65,402	2.98	48	275	13.0	104.8	1,362	623	2,650	2.30	6.60	9.06	1.88	3	6.07	18.563	3.60	11.009
Feb. 17......	10.98	17,480	69,841	3.18	69	253	10.6	95.5	1,012	733	2 680	2.40	7.10	8.19	2.8	4	8.08	23.139	5.61	16.065
Feb. 19......	11.38	12,460	87,972	3.86	58	213	18.0	85.7	1,543	1,042	3,550	2.35	5.40	9.15	2.23	4	8.31	18.893	5.76	13.095
Feb. 20......	11.05	13,750	79,419	3.59	44	312	16.3	110.7	1,805	720	5,800	2.50	7.60	9.20	1.85	4	8.09	20.378	5.61	14.123
Feb. 21......	10.68	11,310	66,438	3.11	48	236	22.9	60.4	1,384	1,100	2,335	2.30	6.40	8.87	1.82	4	7.76	23.360	5.46	16.436
Feb 23......	9.87	13,110	76,453	3.87	42	312	16.6	109.6	1,820	696	9,000	2.10	6.90	8.40	1.47	4	7.17	18.756	5.04	13.184
Totals.......	120.53	143,840	742,923	3.13	561	256	15.4	86.0	1,324	8,629	9,000	2.75	6.90	94.78	25.77	3 & 4	76.13	20.495	49.22	13.250

PERFORMANCE OF FREIGHT TRUCK AT PROVIDENCE LINE PIER.—FOX POINT

1912	Hours in service	Distance (ft.)	Weight (lb.)	Average tons per hour	No. of loads	Average length of haul (ft.)	Total number of pieces	Average number of pieces per load	Average weight of pieces (lb.)	Maximum load (lbs.)	Average minutes per round trip	Wages of men	Cost of labor per ton	Cost per ton for labor 4 weeks in March (actual)	Special test tons handled with known amount of electrical current	Number of K. W. H. used	Fraction of K. W. H. per ton	Cost per ton for current at 10 cents per K. W. H.
Mar. 11...	2.08	4,600	22,750	5.47	21	220	172	8.2	132.3	2,000	5.4	1.25	10.998	....	....	......	......	....
Mar. 12...	4.66	7,620	68,095	7.31	45	169	466	10.4	146.1	2,800	3.1	3.22	9.471	....	....	......	......	....
Mar. 13...	4.42	7,470	47,975	5.43	37	202	248	6.7	193.2	2,400	7.2	2.89	12.482	....	....	......	......	....
Mar. 14...	8.00	12,980	99,177	6.20	72	180	446	6.2	222.4	3,060	6.7	4.83	9.740	....	....	......	......	....
Mar. 15...	3.00	3,420	34,650	5.78	16	213	383	24.0	90.5	3,350	11.3	1.72	9.928	....	....	......	......	....
Mar. 16...	2.25	2,650	35,595	7.91	15	177	237	15.8	150.2	3,750	9.0	1.60	9.000	....	....	......	......	....
Mar. 17...	3.66	8,860	60,010	5.45	49	177	170	3.5	353.0	1,600	4.5	1.98	6.600	....	....	......	......	....
Mar. 18...	3.90	5,350	49,710	6.37	30	178	320	10.7	155.0	2,860	7.8	2.66	10.640	....	....	......	......	....
Mar. 19...	5.08	6,130	57,985	5.71	40	153	489	12.2	118.6	3,040	8.5	2.68	9.241	....	....	......	......	....
Mar. 20...	5.25	9,750	72,285	6.88	52	139	416	8.0	173.8	3,040	6.0	3.11	8.605	....	....	......	......	....
Mar. 21...	3.50	4,280	48,675	6.97	23	186	178	7.7	273.4	6,000	9.1	1.82	7.490	....	38.53	6.5	.17	.017
Mar. 22...	8.00	11,590	104,052	6.05	58	200	1,174	20.2	88.6	6,080	8.2	5.34	10.270	....	....	......	......	....
Mar. 23...	1.39	1,620	19,880	7.22	9	180	68	7.6	277.7	2,240	9.2	.93	9.300	....	55.07	14.0	0.254	.0254
Totals....	55.19	86,320	717,839	6.53	467	177	4,767	10.2	150.5	6,080	7.1	34.03	9.482	22.1	93.42	20.5	0.2193	.02193

this truck is shown in Fig. 155 and in service in Figs. 156 and 157. In Fig. 158 it is conveying about eight times the quantity of freight pushed out of the vessel's hold by two laborers.

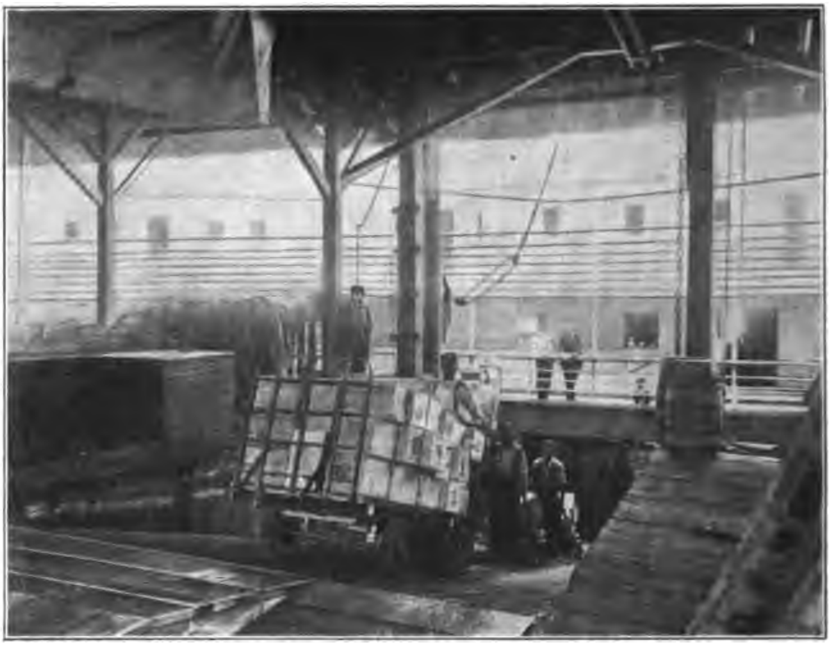

FIG. 158.—Electric freight truck unloading vessel.

On a large New York pier, two motor trucks, during a period of 26 working days, of 11 hours' service, each performed average daily service as follows:

Mileage	13.6
Tons handled	225.0
Tons per hour	20.3
Loads handled	230.0
Length of haul, average	1585.0 ft.
Pieces per load, average	29.8 lb.
Weight per piece, average	88.5 "
Time per round trip, average	2.89 minutes
Time to load, average	58.00 seconds
Time to unload, average	60.3 seconds
Men in gang	8

The Merchants & Miners Transportation Company has 20 electric trucks in operation on its Savannah, Ga., pier, of which Mr. W. P. Coria, Superintendent of Agencies, says:

"The performance records of 13 power-truck loads, after four weeks' operation, as compared with 13 hand-truck loads, handling similar commodities and traveling the same distances, were prepared by me personally. The average weight of electric-truck load was 1531 lb. distance, traveled 748 ft., time consumed 5 minutes 23 seconds, 138 ft. distance per minute, while the hand-truck load averaged 400 lb., time 4 minutes, 46 seconds, 156 ft. per minute. The figures for average time were obtained by cutting out one power truck and one hand truck and timing them. The electric truck made seven stops, distributing freight around the houses, while the hand truck made but one stop. The results show 383 per cent. in favor of the electric truck, in weight handled, and 11.3 per cent. in favor of hand truck in time consumed. The electric truck handled about 8 tons per hour as against 2.5 tons for the hand truck. In moving freight from freight-houses to the warehouses, an average trucking distance of 1170 ft., the work was performed for a fraction over 9 cents per ton, and at 17 cents with the hand truck, a saving of 47 per cent., although these are conditions peculiarly favorable to the power truck, considering the long distance run. At our Savannah terminal the average trucking distance is 637 ft., measured from center of main discharging berth to average of all the warehouses. Varying tides produce inclines from ship's upper "between decks" to the pier surface, of anywhere from zero (level) to 37 per cent. ascending. On the extreme grades the trucks are assisted by inclined drop elevator for power economy. About 70 per cent. of our work can be done by power trucks; the remainder

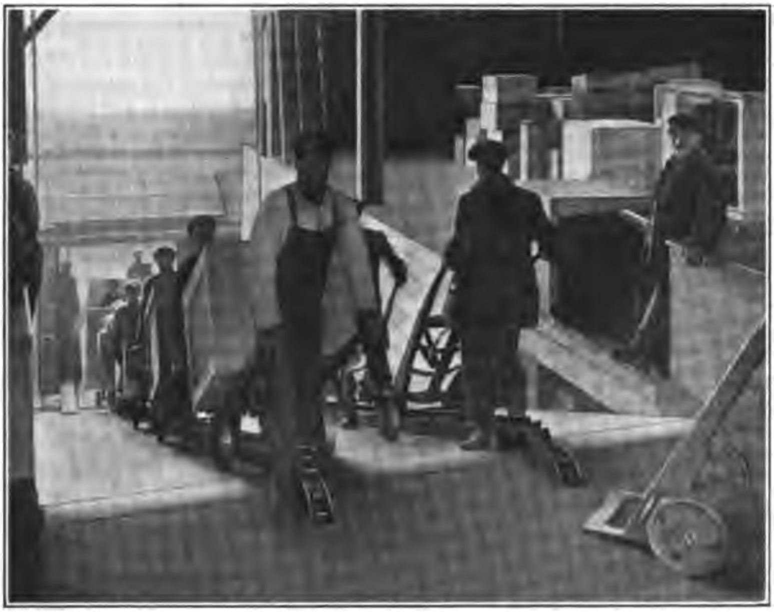

FIG. 159.—Inclined drop elevators, used by Merchant & Miner's Transportation Company.

being handled by hand trucks. Cost for current has averaged 11 cents per truck per day."

The view in Fig. 159 is of the inclined drop elevator referred to by Mr. Coria and in general use by the Merchant & Miners Company.

A record of about 7 months at the Bush Terminals, Brooklyn, N. Y., with a number of battery truck cranes, has been satisfactory.

This apparatus is a flat car with a swinging crane, operated by a 1-ton electric hoist at the forward end, while a storage battery supplies current both for driving the vehicle and the hoist. The crane can hoist material and deposit, and serves as a locomotive to draw cars.

For simple hoisting, the machine is brought into position, the brakes are set, and the vehicle remains stationary as the boom of the crane moves back and forth between the picking up and depositing points. By this method 300 castings, aggregating 65,000 lb., were unloaded from a gondola car in 5 hours; a box car was loaded with sixty-four 800-lb. barrels of plumbage in 25 minutes, and four cars were loaded in 2.5 hours, the latter work including spotting the cars.

When material has to to be moved less than 400 ft., or in small quantities, the article is lifted by the hook, conveyed to its destination by the vehicle, and placed wherever desired. By this pick-up-and-run method, sixty 800-lb. barrels of plumbage were moved 300 ft. in 1 hour, one helper only being required, and one hundred and fifty 500-lb. boxes of rubber were conveyed 75 ft. and loaded into a box car in 50 minutes. For shifting large quantities of freight over great distances, the truck is used as a locomotive, drawing a train of flat cars on which the material is loaded. The train consists of from two to four trailers.

The following represents an average week's work at towing trailers in the Bush Terminal, deduced from the logs of a number of these machines operating over a long period:

Number of packages handled	7,570
Average weight per package	230 lb.
Average distance packages were moved	900 ft.
Total weight handled	1,270,000 lb.
Per cent. of total time machines worked	80
Packages delivered each working minute	3
Number of different jobs worked on	30
Heaviest single load drawn	12.5 tons
Cost of operator, interest, depreciation, power	$24.00
Cost of moving 1 package 900 ft	1/3 cent.
Cost of moving 1 ton 900 ft	3 cents.

The present development in the general application of machinery to handling freight is not altogether satisfactory, but rapid strides are being made; and with the more general use of electric power, the ease with which it may be transmitted and the flexibility with which applied, much will be done in this direction during the coming years. As a factor in reducing the cost of terminal handling it is important; and it is to the terminal handling that we must look for the greatest opportunities.

CHAPTER XXIV

THE FREIGHT AGENT

The duties devolving upon the station agent are complex. The kinds of stations and their importance vary; the qualifications of the men in charge must therefore differ. The large terminal station and the small country stopping place are two extremes; nevertheless, the agent at the small station is in many instances the most important member of the railway's family. His duties are as numerous and varied as those of the yardmaster and he is the medium through which the commercial part of the business with the public, is conducted.

There is no one employee in a railroad's ranks who, in this one essential alone, can do more to make or unmake the status of the road's relations with the public. The passenger conductor may come next but his position has an advantage over that of the agent. He runs into, or reaches, a general terminal as a rule and can therefore be readily directed or instructed by personal interview as well as by circulars and bulletins, and his duties are so uniform that a hundred conductors may be told the same thing. The agents are scattered as to locality and their duties cover a very wide range. It is frequently difficult to interview them and, as each one has individual characteristics or is surrounded by peculiar local conditions, he must be treated separately. The traffic may be peculiar to his territory—as for instance, in the case of granite quarries—and he has no nearby precedent to follow. The shippers may have peculiar ideas; they may have been permitted certain privileges which, if objectionable, must be withdrawn diplomatically; and local or state laws may affect the situation.

To enumerate the duties of the smaller agent would require a large book. The duties of the larger agent are even more exacting although somewhat specialized. Both are required to meet the public and in their dealings with it, must exercise discretion, patience, and diplomacy. In the small towns especially, where the road's officers do not have many opportunities to coach him, the agent may be inclined wholly to the side of the public and forget his duties to his employer. He should always remember that his first obligation is to the road employing him, and that loyalty to the road does not in the least detract from his standard of citizenship. The greatest, and probably one of the commonest mistakes an agent may make, is simply to answer questions, after declining something or discontinuing a privilege previously enjoyed by a patron, without carefully explaining the reasons or necessities. The simple statement "Those are my orders" merely aggravates. A train may be late; a shipment fails to arrive; certain switching cannot be done; there is usually some reason—good or bad—for the failure. While the agent is not personally responsible for such failure, it will go a long way toward creating or strengthening good feeling between the company and its patrons if he will take a little time and trouble to explain the situation. Very few persons are so unreasonable as to find fault or hold a grudge against a railroad company, if they know there is a reason for a failure and that the employees, as well as the officers, are sufficiently interested to explain it. It goes without saying that nothing should be misrepresented, but this does not mean that the blackest side alone should be presented. Agents should not be influenced or prejudiced one way or another because some unreasoning or unthinking person indulges in abuse of the road or its officers; they should remember that the custom of denouncing railroad corporations is a common habit of demagogues and others who are ignorant of true conditions, and who usually follow the lines of least resistance.

In an address to an association of agents, Mr. J. M. Daly, General Superintendent of Transportation of the Illinois Central, said:

> "The position of agent is a very important one. You handle the entire business of the railroads. Every dollar that we earn is handled through your office. In the State of Illinois we have 417 industrial corporations that employ expert traffic managers to look after their railroad service. Most of these men formerly were employed by railroads. These gentlemen make a specialty of rates and service on from one to three commodities and devote their entire efforts to obtaining the best possible service at the lowest price. These industries keep a detailed record of the movement and service afforded each individual shipment, the small shipper or receiver of freight is equally anxious for prompt and efficient service and must receive the same attention. It is true that frequently unreasonable demands, and requests are made on you. . . . . . In winter the public moves its traffic by team during daylight hours, 8 a. m. to 4 p. m.—8 hours out of 24—and demands increased free demurrage time, whereas the shipper who is obliged to wait for cars (that are detained by the consignee) demands damages in the shape of reciprocal demurrage. In meeting these conditions, it is well to explain and make known our position. Shippers demand that we furnish our cars to load for distant points on foreign roads where we lose possession of them, the foreign roads holding and using our cars locally as long as desired. The average shipper and consignee does not understand and consequently cannot appreciate the difficulties we labor under, and the company must depend upon you, gentlemen, to make it known to them, not with a view of finding fault, but in the same friendly manner that shippers make known their conditions to us.
>
> "If a patron asks you what train connections he can make with other roads, figure it out for him, and, if necessary, use the wire to get it for him. If a shipper

asks you why it is that the rate on his hay or his live stock is 25 cents per hundred, whereas the rate to the coal or lumber dealer is 5 cents or 10 cents between the same points, reason it out with him; show him where coal loads 50 tons to the car and live stock only 10 tons; further, that live stock is moved in fast trains hauling less than 20 per cent. as many revenue tons as coal trains. The public is not informed on such matters, and if you are patient and careful in explaining, you make a friend to yourself as well as to the company. I have attended quite a number of investigations made by the different State legislatures, the State and Federal commissions, and firmly believe these gentlemen aim to do what is just and fair, but they receive information on but one side of the case—that of the public—and their opinions are formed accordingly. Bear in mind at all times that a complaint from a patron shipping one car a year is as important as a complaint from a shipper giving us a hundred cars, and that the small shipper has an equal influence in any organization of which he is a member. If you, by giving him facts, convince him that we are doing our best to protect his interests, you will find that he will be our friend and co-operate with us. If the local agents will get together with the shippers and discuss their grievances carefully, I am satisfied that eight out of ten cases now brought before the commissions and legislatures could be disposed of in your conferences and never reach the commission. The average shipper is fair and wants only fair treatment, and when he is shown that he is receiving fair treatment he will be satisfied."

As the adjustment of a terminal to the conduct of the period of heaviest traffic coupled with adverse weather and other conditions, measures the ability or efficiency of the road, so the true measure of the agent himself, his organization and his plant, will show up most effectively during heavy freight movement, and particularly when this occurs during a period of unfavorable weather when teamsters postpone hauling freight out of houses and cars, while the railroad must of necessity continue to haul it in. During such times of heavy pressure agents must exercise the utmost tact while firmly insisting on patrons removing freight promptly on arrival. Frequently a careful explanation of the situation in a personal interview with a heavy shipper will result in securing prompt and hearty co-operation. The agent who has the respect of the community has no great difficulty in such cases; he is the agent who has made himself popular by being at all times courteous and considerate. He is not the one without the moral courage to defend his company and state facts courteously but plainly when imposition is attempted or denunciation indulged in.

The conduct of the smaller, or so-called "one-man station" needs little on the question of organization beyond a reminder, possibly, that even there much work may be saved and more satisfactory results achieved by working systematically; having a place for everything and keeping everything in its place; a time, so far as practicable, to do certain work and keeping ahead of the work. No freight should be delivered without a proper receipt. Freight unloaded should always be checked by the agent and conductor jointly and shortages, overs or damages certified to jointly and immediately. No "over" freight should be permitted to remain on hand any length of time without calling the claim department's attention to it. Tracers for lost freight should be given actual attention; not treated in a perfunctory manner. "Order-notify" shipments should be invariably held until the bill-of-lading is presented; waybills should be very carefully scrutinized to avoid overlooking these "order-notify" notations, which are the source of much trouble to the agent. Outbound freight should be inspected to see that proper classification is observed; that freight is properly crated and plainly marked; rules for handling of explosives and inflammables observed and the goods carefully and securely loaded into cars to prevent damage in transit.

Automatic couplers accompanied by increasing size and weight of locomotives and cars increase the liability of damage to freight and make necessary greater care in loading and in switching. Freight-house men must be taught to load large cars with package freight so as to prevent shifting. After part of such a car is unloaded, the remainder must be arranged to avoid shifting.

In attempting to reduce the damage to freight in transit—and it is a big field—the panacea is undoubtedly more inspection and supervision of a more intelligent character. British railroads employ many inspectors and their system is well worth imitating.

Some of the smaller matters the agents should look for to reduce claims, and, what is more important, to satisfy patrons, are in the loading. Cases have been known where meat recently killed was loaded on butter, covering the tubs with blood. Machinery was loaded on flour or sacks of sugar. Agricultural machinery was loaded on top of an automobile. Flour is frequently damaged by being loaded in a car with a leaky roof. Wet sacks of flour should be re-sacked; very little around the edges is damaged and sticks to the sacks. It should be handled promptly or it will become mouldy. After unloading part of a car, the remainder should be broken down so it will not fall and be damaged if the car is moved. An agent once left a piano under the eaves of a freight-house where it was damaged by rain.

There has been a tendency, on the part of shippers of late years, gradually to discontinue the full marking of packages. Nothing causes more loss of freight, or delay in reaching destination. There has also been a general indifference to properly crating; and weaker packages are being used. Boxes and sacks are made of thinner material, crates are substituted for boxes, and sacks are used by some shippers for articles which should not be shipped in them. Every package, bundle or piece in an l.c.l. shipment, should have:

Consignee's name in full.

Bill-of-lading destination in full.

State in which destination is located.

If more than one station in same state of same name, full name of county.

All previous shipping marks obliterated.

Shipper's name and location, with the word "From" preceding them.

A package may be fully marked in so far as name of consignee and destination are concerned, even the street address being shown; yet it may be more or less confused by being surrounded by a multiplicity of other information. This may cause the loss of the package or a delay in delivery.

The presence of the shipper's name is of assistance as a means of identification of a package and is of great value when it is refused or unclaimed by consignee, as in all such instances the shipper can be promptly notified, and if date of shipment and case number are shown, he can also be given this information, which will enable him at once to locate the particular shipment involved. When shipments are made at regular intervals or short periods the presence of the date of shipment and the case number prevent any uncertainty as to which lot one or more packages belong, in case they check short and reach destination on the same date or subsequently to a later shipment.

Carelessness in not properly marking frequently causes misdelivery, as in the case, not long ago of a bale of hay on which there were no shipping marks attached to it in any manner. There are various kinds and qualities of hay; the average shipper ships any of it as a "bale of hay" and it is so written in the waybill. When the local freight rolls up to a station after losing time—its usual habit—the conductor, hurriedly glancing over the waybills, sees these is a bale to be unloaded for John Smith.[1] The car door is opened; he sees three bales and as all look alike to him he unloads the handiest one and goes on. A little further down the road he unloads a second bale for Bill Jones and before reaching the end of the run he unloads the last for Tom Johnson. Now, in this special episode, John Smith ordered a bale of number one timothy and when he received a bale of number two he was mad clear through; thought the shipper was trying to cheat him and so wrote him. Bill Jones had ordered a bale of number two timothy and got the bale of clover that Tom Johnson ordered and when Tom got the bale of timothy that John Smith ordered, both were hotter than hornets and took to letter writing; and before the affair was over everybody, including the claim agent, had hay fever—all arising from the lack of proper marking on the bales.

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[1] This story and other information was obtained from a pamphlet "Why Freight is Lost or Damaged," by A. C. Kenly, of the Atlantic Coast Line.

Some shippers of hay slip the tag bearing the marks under one of the wire bands. It should also be tied to it, as there is always the chance of its working out, thus leaving the bale without marks.

The cut Fig. 160 represents the ordinary method of shipping small orders of stoves. It is well known how easily cast iron is cracked or broken by a blow or falling article. Depict this article in a box car of a hundred thousand pounds capacity, surrounded and overtopped—for nothing can be piled on it—by a miscellaneous assortment of articles ranging from an inoffensive sack of flour to a box of hardware stowed high above it, which may fall on it with deadly effect at any minute, being thrown from its apparently secure position by the swing of the fast-moving train around a sharp curve or by the shock of the sudden application of the brakes.

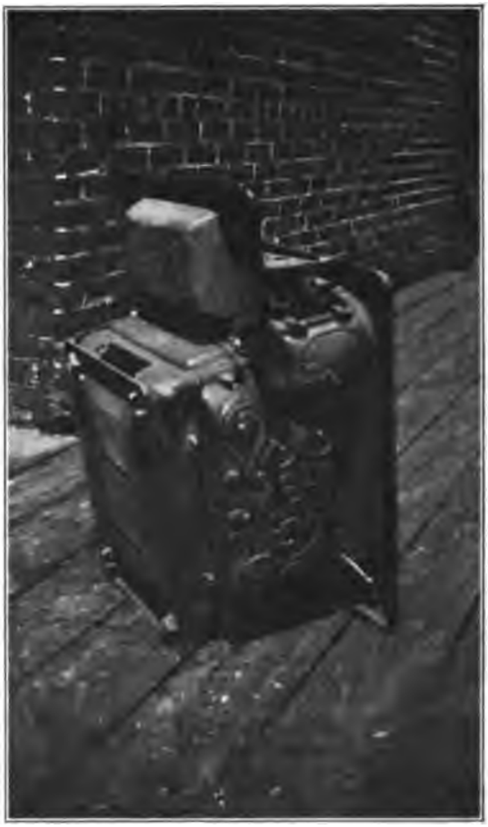


Fig. 160.—Ordinary method of shipping stoves.

The group shown in Fig. 161 represents another source of petty claims—broken chairs. Those of value should be crated; cheaper chairs should be shipped "knocked down" in full or part and set up at destination. No unprotected article should be shipped unless of a nature to withstand the ordinary wear and tear of transportation.

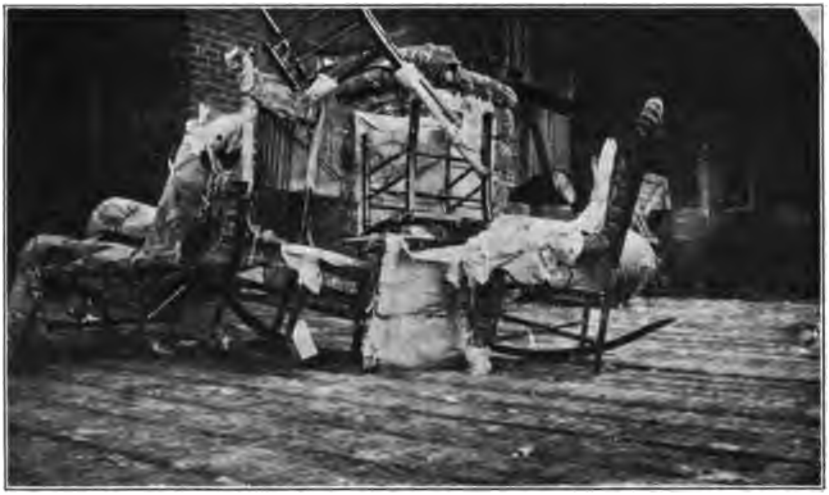


FIG. 161.—Improper method of shipping house-hold furniture.

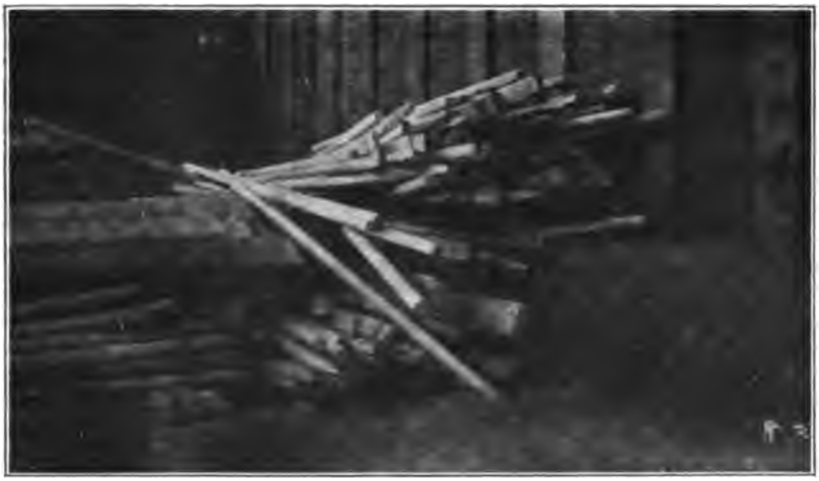


FIG. 162.—Improper packing of spokes.

The exhibit in Fig. 162 is an example of the improper packing of the articles shown and applies to all similar articles, showing the condition in which a great many bundles reach their destination; many spokes are lost and claims necessarily follow.

The indifference of the ordinary manufacturer or jobber to proper and safe packing and marking, is almost incredible. He will spend very large sums in extensively advertising his wares and in sending salesmen out, but after the goods are once sold he seems immediately to lose all interest in them. A pleased customer must be one of the most valuable assets to a manufacturer as well as to a railroad company; the customer who does not get his goods promptly and in good condition is certainly not satisfied. The agent has an extensive and important work to educate shippers at his station in these matters and to keep himself informed as to the company's rules relative to marking, crating and packing; and conveying such information to the shippers.

Interstate Commerce Commissioner Harlan, in an address before the Conference Committee of the Freight Claim Association, Nov. 20, 1909, said:

> "In my judgment, it is not only the common law right, but the duty of a carrier to refuse to receive shipments that are not adequately marked. It owes that duty to itself and it owes that duty to other shippers who desire to use its facilities and to get prompt service, relieved of the embarrassment and delays caused by the failure of other shippers to mark their packages clearly. It may be that upon further reflection I shall be compelled to another view of the matter but, as at present advised, it seems to me that even though a railroad carries in its tariffs no rule to that effect, no court would compel a carrier to receive a shipment that was not properly marked, or so clearly marked as to enable it to make delivery promptly and without additional labor. I think the commission will so hold in the case now before it. It will, as I think, object to a tariff rule that permits a carrier to charge a higher rate because packages are not properly marked, but will rather insist upon the view that it is the carrier's duty not to receive parcels that are not properly marked."

CHAPTER XXV

OPERATION OF FREIGHT HOUSES

At small stations the freight house is usually of the "combination" type, in which both inbound (arriving) and outbound (departing) package or l.c.l. freight are handled; while at large stations one or more houses may be in use for inbound, with similar separate facilities for outbound freight.

The administrative and supervisory organization of a freight house differs according to the size of plant, its general arrangement and the local method of conducting the business. In general terms, the agent (with possibly an assistant) requires the services of a chief clerk, a cashier, chief bill clerk, and as many supporting clerks as the volume and character of the business demand. The larger stations are here considered because the smaller stations require so many and varied duties that each one may be a story in itself.

A general house foreman is in direct charge of the freight-houses, and is usually assisted by a foreman for each inbound house, each outbound house and the transfer station, if they are extensive and separately operated. In smaller and compact layouts, one foreman may suffice for all. Each house, including the transfers, has one or more trucking gangs. The number of men in a gang varies according to the distance to be trucked, size of house, etc. A stevedore is usually provided for each gang to stow freight into the car or to break it out. A tallyman for each gang checks the freight with the waybills on inbound; receiving clerks receive outbound freight from teamsters and check it with shipping bills; mark it and observe if the rules for handling explosives and inflammables are complied with and that the proper tariff classifications are followed. Usually more men are needed in the inward house during the forenoon and in the outward house during the afternoon; and it becomes necessary to balance the force carefully as may be required. In some instances men have been advantageously transferred one or two miles on street cars or by other means of conveyance, where the houses were that far apart.

Byers, in his "Economics of Railway Operation" estimates the value of some thirty freight stations, including tracks and driveways, at $12,000,000; these stations handled about 1,000,000 tons of bulk or car-load freight and 400,000 tons house freight a month at an average expense of $166,000 for station forces and switching, to which was added $104,000 for interest and depreciation—10 per cent. on value of plant—giving an average expense per ton for handling freight:

Interest and depreciation	28.6 cents
Station force and shipping	41.5 cents
Total	70.1 cents

He concludes there is no general relation between freight-station areas and tonnage handled as affecting ton-cost and he cites a Baltimore freight station with an area of 330 sq. ft. per ton of freight handled—at a cost of 44 cents; a New York house 150 sq. ft. and 56 cents; a Jersey City house 170 sq. ft. and 95 cents; a Chicago house 340 sq. ft. and 98 cents a ton. Design and management seem to be the controlling factors, although with the best management the cost may be high, due to the peculiarities of the business at that terminal.

In figuring the cost of handling, interest and depreciation are not included. There are as many methods of computing cost of freight handling as there are of computing cost of car handling. One large railroad system has ruled that "all freight-house labor that is employed in receiving, loading, unloading, delivering and transferring freight, should be included; and the wages of house foreman, assistant foremen, receiving clerks, loading clerks, assistant loading clerks, delivery clerks, tallymen or checkers, stamp men, transfer clerks and checkers (not including men on records), sealers, stevedores and freight handlers or truckers."

The Local Freight Agents' Association, in 1902, adopted this classification:

1. General Supervision—consisting of general foreman, assistant foremen, clerks and such watchmen and sealers whose work extends over warehouse, platform and team yards.

2. Supervision and Clerical Work—consisting of:

(a) *Warehouse.*—Foremen, clerks, receiving checkers, loading and unloading checkers, delivery checkers, weighers and watchmen, and sealers not included under general supervision.

(b) *Platform.*—Foremen, clerks, loading and unloading checkers and watchmen, and sealers not included under general supervision.

(c) *Team Yards.*—Foremen, checkers and watchmen, and sealers not included under general supervision.

3. Labor—consisting of:

(a) *Warehouse.*—Loaders, packers, truckers, coopers.

(b) *Labor.*—Loaders, packers, truckers, coopers.

(c) *Team Yards.*—Laborers engaged in loading and unloading package freight on team tracks.

They also recommended the following tonnage classification:

Warehouse Freight.—General merchandise received and forwarded; includes handling from cars to teams and from teams to cars.

Platform Freight.—Freight transferred at platform from car to car or checked from and returned to same car.

Team Yard Freight.—Freight handled from cars to teams or taken from teams to cars, when supervision, checking or labor is furnished.

To arrive at the total number of tons handled credit should be taken but once for the actual number of tons handled in receiving and disposing of the freight.

The cost per ton for handling is to be obtained by dividing the tonnage obtained as above into cost for labor at warehouse, platform or team track.

Total cost per ton for operation is to be obtained by dividing the tonnage obtained as above into the total cost for supervision, clerks and labor at warehouse, platform and team tracks.

The Local Freight Agents' Association, in 1904, interestingly discussed the loading of freight. One member described the so-called "drop truck" system, in which the trucker leaves his empty truck and takes one loaded in the car or at the dray. He also objected to the "double check" and "double handling" usually employed when receiving clerks check, inspect and receipt for freight at the dray; and loading clerks rehandle and recheck when consignment is sent to the car instead of accepting the check of the receiving clerk alone. He claimed the loading clerk was duplicating the work of the receiving clerk which made it expensive, and that there was a further waste of time when truckmen waited for their loads; that shipments should be received, inspected, weighed, loaded on trucks and receipted for at one handling, doing away with the labor of a receiving clerk. He accomplished this with the "drop truck" system, by which the trucks, as soon as checked, loaded, weighed and packages marked with chalk for the car into which they were to be loaded, were dropped near the center of the warehouse or platform and conveyed to the car without delay to the truckmen, as they made their regular rounds. This requires a larger supply of trucks; from four to six trucks for each truckman. A competent check clerk with a good attendant or truck piler placed in charge of one, or as many more doors as he can take care of, to receive, receipt, inspect, weigh and load freight at one handling. The drayman presents shipping bills for what he has on his dray. Each shipment should be loaded on the dray together at shipper's wareroom, in order that it may be checked and loaded on truck to advantage when received. As freight is received from the drayman, and loaded on the trucks, it is inspected as to condition, description and marks, and called to the checker near by, who checks with the shipping ticket received. It is then weighed and marked with a number designating car into which it is to be loaded, for guidance of truckmen in distributing the loaded trucks to the cars. All the movements of a double check being concentrated into one transaction, gives the check clerk in charge ample time to keep watch of the movements of truck piler, check articles called, secure correct weights, note exceptions, consider all points necessary in receiving and loading of freight, insert on shipping ticket retained for billing clerk, number of car and initial in which loaded and issue receipt at once. This is done in a systematic, thoughtful and business-like manner; the public is served promptly and satisfactorily, at the same time held in check against questionable methods of transacting business and chances for errors and disputes are avoided or reduced to the minimum. Such a system can be applied advantageously at any of the minor shipping points by employing any slack time of check clerk and piler in conveying the loaded trucks to cars and bringing back an empty truck in return, and at the same time keep in close touch with receiving doors.

Another member described his method of handling as follows:

> "We have a warehouse about 750 ft. long and comparatively narrow; we work twelve check clerks; each has three doors, and a "picker" to assist him. The freight is handled from the wagon. The picker, with the assistance of the drayman, loads a truck, hauls it across and has it weighed; and the check clerk, who has the ticket, calls the number of the car to which the shipment is to be trucked. The picker check marks the shipment on his truck, "1701," for instance, and runs the truck out in the center of the warehouse and leaves it. He gets another truck and continues until he has unloaded the wagon. Our truckmen are not worked in gangs. The truckman gets a load of freight and takes it to 1701, or any other spot and leaves it there, where he usually finds trucks. If not, he walks directly across the warehouse and finds empty trucks, taking them with him if he needs them for unloading another wagon."

In the Grand Trunk's Toronto freight yards, all tracks are numbered, the house tracks running from 1 to 8 and the team tracks continuing up to 18. The latter are accessible to teams directly from the street. For the guidance of teamsters, the team side of the outbound house has the different doors marked with lettered boards, to indicate where goods are received for various "runs" and such goods are accepted only at the proper doors. On the inside of the doors on the track side of the house there are boards to indicate the runs and tracks. All doors are numbered. The cars on the house tracks are spotted in placing, to give free access to each car and to the transfer platform. The five outbound tracks are divided into sections or train loads, to obviate unnecessary switching. The trains to be despatched first are placed at the outer ends of the tracks to facilitate movement and avoid disturbance to the work of loading.

Gang checkers direct the movements of the men. A list is made out each morning showing cars and location and copies furnished to the checkers. Truckers are given numbers and are directed by a checker, who chalks packages to show what trucker handles them and in which car they are to be put, as well as the number of the track on which the car stands. For example, a package for trucker No. 81, car No. 14, on track No. 3, is chalked "81–14–3." This enables the stower to locate errors in placing. Each stower has two tiers of cars—ten in number—on the outbound tracks and attends to the loading of these cars by the truckers. Carloads of cartage freight are delivered on the team tracks, Nos. 11 to 18, checkers in charge handling the goods direct to teams. Tracks Nos. 9 and 10 are used for outbound carload traffic, which is loaded direct from the teams, the freight being weighed on team track scales.

The simplest system of loading freight is that known as the verbal. The tallyman receiving and weighing the shipment, instructs the trucker to take it to a certain car; on his return the trucker repeats the car number to the tallyman, whereupon he checks it off on his waybill.

Many freight and transfer stations are introducing, with varying success, the system of handling freight and paying for it on the tonnage basis—an application of the "piece work" system. The success of this method and the details for working it depend largely on the class and cost of labor and the kind of commodities handled. There are various methods under which this may be worked; among others is that of taking a careful record of the handling of the freight and figuring on the cost per ton. One rate is usually made for package freight and another for carload or bulk freight. At times other rates are made for certain kinds of commodities which run heavily. A record is then kept of the number of tons handled by each laborer. In some cases the men pool the work and the amount is paid in a lump sum to the foreman or leader of the gang employed. The work may also be let out on the contract basis at a stipulated rate per ton to the foreman or a contractor, who in turn makes his own bargains with the laborers. No attempt should be made to lower the actual cost of handling materially. The company's advantage consists in securing fewer and better men and in eliminating the labor agitator or disturber. It also results in quick handling of freight, as the men will hurry or work overtime when necessary. In practice it has been found that the cost per ton for handling freight is quite like in amount to the rate of wages, figured on the hourly basis.

The use of a rubber stamp, to stamp on each package received, the date, approximate hour and car from which unloaded, has been the means of securing the delivery of many pieces of freight that would otherwise have found their way into the pile of unclaimed freight, and, later, into the "old hoss" sale. Many packages may be traced to an originating point in this way, where the entire absence of marks would otherwise indefinitely "sidetrack" it.

At freight-houses large, easily read signs should be placed at openings, indicating the points for which freight is received at such openings, and freight for such destinations as go into any one car should be kept together. Cars should have placards or numbers attached, to indicate the destination or destinations, and the cars should be so placed as to permit the least possible trucking of freight. If a series of tracks is used, with trucking or landing platforms between the cars on the tracks, a compound numerical designation may be used, the first number (separated from the second by a hyphen) indicating the track, and the second the order of the car on the track, counting from one end of the house. Thus: 1-10 indicates car 10 on track 1. A painted sign-board or "flag" box is hung on this car, lettered "1-10," and all freight for it is marked "1-10" with a crayon, or a card accompanies it, bearing that number according to the system employed. The return ballot system requires a trucker to go into the car, deposit his freight and take from a hook inside the car one of the checks marked "1-10" and return it to the checker who loaded the truck.

Still another system designed to insure the loading of freight into proper cars and prevent its going astray, requires the use of a checking machine and booth for each checker. It has been successfully used, especially at stations and piers where shipments originate. The trucker passes the checking machine and presses a lever which throws out a card giving the flag number of the car into which the freight is to be placed and a consecutive number for tracing purposes. The same movement also stamps the waybill and adds the date on its face. The trucker deposits his check in the flag box on the outside or on the door of the car. These boxes are kept locked while the cars are being loaded. After the day's loading has been completed the agent or his representative unlocks the boxes and goes over the checks. If any checks are in the wrong boxes it indicates improper loading, and by reference to the waybills the shipment and its destination may be located, and by wiring the first transfer point or station at which the car stops, the freight may be recovered and started in the right direction. At some stations the flag box is used without the machines. The trucker is given a check with the flag box number for each load. This he deposits in the locked box, and an inspection afterward will reveal if any stray freight is in the car. The tracing is somewhat more complicated.

The Chicago & North-Western has in operation in its Chicago freight-houses a method of loading and unloading l.c.l. freight which has been worked out in minute detail. The principal freight-houses are at State Street, Grand Avenue, Wood Street and 16th Street. The State Street house receives from and ships to the Galena division, and the Grand Avenue house, from and to the other two divisions. Wood Street is a transfer freight-house for freight to and from connecting lines delivered in cars, and Sixteenth Street for connecting line freight for the

North-Western delivered by teams. The mixed freight (except perishable) from the road for connecting lines received at Wood Street is there distributed into the proper foreign cars. Practically the only freight for Chicago received at either Wood Street or Sixteenth Street is in carload lots for delivery on near-by team tracks.

The State Street outbound freight-house loads cars for all points on the North-Western Line, large deliveries in l.c.l. lots being made at the house daily by teams. Five tracks of 18 cars each, 90 cars in all, are loaded at a time. The 90 cars are divided into 19 "runs" of five cars each. The first run is made up of the first car on each of the five tracks; the second run comprises the second car on each of the five tracks; and so on, up to the last or nineteenth run. Each run is in charge of a stevedore who is entirely responsible for correct loading. To make his responsibility complete, freight is not wheeled into the cars by the truckers. They leave the loaded trucks on the freight-house platform just outside the door of the first car in the run. Then as the stevedore takes each piece of freight into the car himself, all mistakes in loading can be traced directly to him. It is also his business to examine each piece of freight for its actual destination instead of depending on the marker's chalk marks which are intended solely for the direction of the trucker.

New York, Boston, Philadelphia, West Albany Transfer, Buffalo, Cleveland, Pittsburg, Alliance, Columbus, Ft. Wayne Transfer, the Erie Despatch, Lackawanna Despatch and Merchants Despatch Transportation Co., are among the eastern points and the fast freight lines which load straight cars for Wood Street. These cars contain nothing but freight for points beyond Chicago on or via the Chicago & North-Western. A mixed car, for instance, containing merchandise, part for some point on the Chicago & North-Western, the rest for Grand Avenue or State Street, Chicago, would be returned to the connecting line for proper loading. Straight cars from connecting lines are switched at Wood Street to the proper westbound track for handling by transfer trains. Foreign cars of mixed freight are run into the freight-house from the east end on a track running through the center of the house. They are then unloaded and their freight reloaded into cars for the road, those from the Galena division being on the four tracks at the north side of the freight-house and those for the Wisconsin and Milwaukee divisions on the four tracks at the south side. As the front cars in the house are emptied, the whole line is pulled through, the empty cars detached at the north end of the line and the whole process repeated. If it is necessary to unload at once more connecting-line cars than the number which this track inside the freight-house will hold, extra cars may be unloaded at the south end of the house, where there is a platform 30 cars long. About 125 cars of such mixed merchandise freight are received daily from connecting lines. Some 60 or 70 of these cars are daily sent back to their home roads after having been loaded with connecting-line freight which comes in mixed cars from points on the North-Western Line. These mixed cars from the road are unloaded on platforms at the east end of the house.

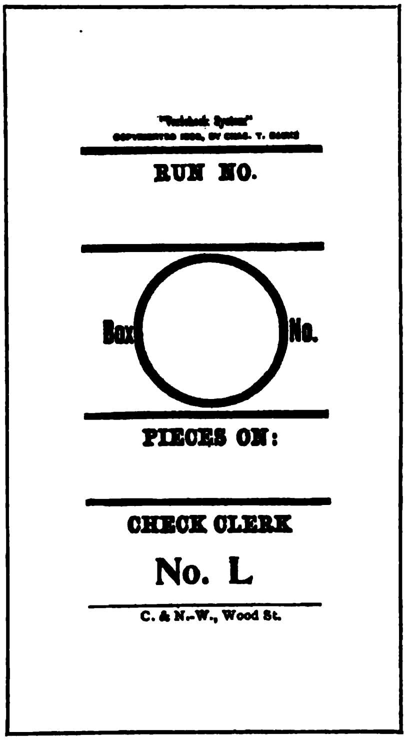
The accompanying loading plan shows the arrangement of cars loaded for the road at Wood Street, (Fig. 163). Each numbered space represents a car. Runs 1 to and including 14 on tracks 1 to 4 inclusive are on the north side of the house and are cars for points on or via the Galena division. Runs 16 to 31 are on the south side of the house and are cars for the Wisconsin and Milwaukee divisions. As will be seen from the chart, most of the cars are way or peddler cars which run on through trains to the beginning of their respective territories and over their territories on way-freight trains. On these cars it is, of course, important that freight for the first station in the peddling territory be loaded next the door. Straight cars, on the other hand, such as the one for Elgin, Run 6, Track 1, or the nine for points west of Omaha, Runs 1 to 9, Track 4, are loaded with no care for any special arrangement inside the cars. The runs are the same as at State Street, but instead of marking with chalk on a box of freight destined for Elgin, "6–1," as would be

CHICAGO & NORTH WESTERN RAILWAY
WOOD STREET STATION. ____________190

TRACK ONE				TRACK TWO				TRACK THREE				TRACK FOUR							
[illegible]	STATION	[illegible]	Car No.	[illegible]	STATION	[illegible]	Car No.	[illegible]	STATION	[illegible]	Car No.	[illegible]	STATION	[illegible]	Car No.	[illegible]	STATION	[illegible]	Car No.
1	AUSTIN TO OAK PARK	1		1		2		1	KELLY TO DES MOINES	3		1	OGDEN	4		1			
2	RIVER FOREST TO CORTLAND	5		2	SYCAMORE AND DE KALB	6		2	Marshalltown and Iowa Cent.	7		2	U. P. TRANSFER	8		2			
3	ELVA TO Spring Valley	9		3	NACHUSA TO MALTA	10		3	CEDAR RAPIDS	11		3	SAN FRANCISCO	12		3			
4	TERRA COTTA to WILLIAMS BAY	13		4	DIXON	14		4	CLINTON OIL	15		4	SACRAMENTO	16		4			
5	DUNDEE TO ALGONQUIN	17		5	STERLING	18		5	CLINTON TO LUZERNE	19		5	POCATELLO	20		5			
6	ELGIN	21		6	FULTON TO LIMESTONE	22		6	BOONE TO GLIDDEN	23		6	U. P. TRANSFER	24		6			
7	PECATONICA TO WAYNE	25		7	[illegible]	26		7	[illegible]	27		7	PORTLAND	28		7			
8	FREEPORT & RIDOTT	29		8	MASON CITY TO [illegible]	30		8	[illegible]	31		8	PORTLAND	32		8			
9	ROCKFORD	33		9	[illegible]	34		9	[illegible]	35		9	COLORADO	36		9			
10	BELVIDERE	37		10	[illegible]	38		10	[illegible]	39		10		40		10			
11	BATAVIA	41		11	[illegible]	42		11	[illegible]	43		11		44		11			
12	AURORA AND NO. AURORA	45		12	[illegible]	46		12	BLAIR TO BORDEAUX	47		12		48		12			
13	GENEVA and St. Charles	49		13	[illegible]	50		13	OMAHA, Via Blair	51		13	LYONS TO ANAMOSA	52		13			
14	WEST CHICAGO	53		14		54		14	Council Bluffs	55		14	PEORIA	56		14			
15		57		15		58		15		59		15		60		15			
16	NO. CHICAGO & WAUKEGAN	61		16	WOODSTOCK TO HARVARD	62		16	[illegible]	63		16		64		16			
17	[illegible]	65		17	WIS. DIV. OIL Cars	66		17	OSHKOSH TO NEENAH	67		17	POWERS TO MICHIGAMME	68		17			
18	NO. EVANSTON TO ZION CITY	69		18	MINNEAPOLIS	70		18	APPLETON TO GREEN BAY	71		18	MILTON JCT. TO GARFIELD	72		18			
19	KENOSHA	73		19	MINNEAPOLIS	74		19	MILWAUKEE	75		19	KIRKWOOD TO GALESVILLE	76		19			
20	RACINE JCT	77		20	ST. PAUL	78		20	MILWAUKEE	79		20	SPARTA TO LA CROSSE	80		20			
21	RACINE	81		21	ST. PAUL	82		21	MILWAUKEE	83		21	[illegible]	84		21			
22	DEERING TO EVANSTON	85		22	[illegible]	86		22	MILW. NORTH	87		22	WINONA	88		22			
23	Winthrop Harbor To So. Milwaukee	89		23	DULUTH	90		23	MILW. WEST	91		23	WINONA TRANS.	92		23			
24	MINN. TRANS. G.R.	93		24	WEST SUPERIOR	94		24	SHEBOYGAN TO PLYMOUTH	95		24		96		24			
25	MINN. TRANS. G.N.	97		25	HUSTLER TO ALTOONA	98		25	LAKE SHORE JC TO KIMBERLY	99		25	SUGAR BUSH TO MARSHFIELD	100		25			
26	MINN. TRANS.	101		26	JANESVILLE	102		26	FOND DU LAC	103		26	BIRNAMWOOD TO ASHLAND	104		26			
27	MINN. TRANS.	105		27	BELOIT	106		27		107		27	[illegible]	108		27			
28	MINN. TRANS.	109		28	CALEDONIA TO BARABOO	110		28		111		28		112		28			
29	MINN. TRANS.	113		29	HIGHWOOD & LAKE FOREST	114		29		115		29		116		29			
30	CUDAHY	117		30	HIGHLAND PARK	118													
31		121		31		122													
32		125																	

FIG. 163.—Loading chart for Wood Street freight-house, Chicago—Chicago & North-Western.

done there, the trucker is given a ticket (Fig. 164) which would be filled out in this case: Run No. 6, Box No. 21. A tin box with a number on it is hung on a nail in each car. The box in the Elgin car is box No. 21, because counting from the first car on the first track and across and so on down it is the twenty-first of the Galena-division cars. Similarly Run 17, Box 67, is a way-car from Oshkosh to Neenah over the Wisconsin division, and is the second car on the third track south of the house and, counting in the way described, the sixty-seventh car from the first car on the first track of the Galena division.



RUN NO.

Box No.

PIECES ON:

CHECK CLERK

No. L

C. & N.-W., Wood St.

FIG. 164.—Trucker's ticket used at Wood Street freight-house, Chicago—Chicago & North-Western.

The unloading of each foreign car on the track in the center of the house is done by a gang of seven men, a checker, caller, and five truckers. The checker makes out a ticket for each piece of freight as it is brought out of the car. This the trucker takes along with him and drops into the box of the designated car when he deposits the freight in that car. Before the train leaves for the road, an inspector goes into each car and examines all tickets to see that no mistakes have been made. There is a stevedore for each run who, although he does not himself truck the freight into the cars as at State Street, is responsible for its being in the right car and for its arrangement in the car. The weight of each piece in each car, taken generally from the waybill or as weighed when taken out of the foreign car, is recorded on a slip by a clerk in the office and the total tonnage unloaded from that car credited to the gang which did the work. Instead of being paid by the hour, as at State Street, the check clerks, callers and truckers are paid on a tonnage basis, the amount actually handled from each car being credited each to the checker and the caller and divided equally among the five truckers. A minimum day wage is paid in case the tonnage payment falls below that amount, but this seldom happens. The system is said to have worked satisfactorily both to the company and to the men. The same system has not been applied at any of the other freight-houses because at all of the others freight is received by teams, and by collusion between truckers and teamsters some men would be able to make large earnings on the tonnage basis by getting all the heavy freight to carry, while others would handle only light freight and would make correspondingly low wages. At Wood Street the freight is trucked just as it comes from the cars and each set of truckers has exactly the same chance.

The 103 cars designated on the Wood Street loading chart are the very least number of cars loaded in any one day. The average at Wood Street is about 130 cars per day. The extra cars not designated on the chart (most of which are usually "straight" cars, for instance extra cars for San Francisco or Minnesota Transfer) are set for loading on the tracks in places represented by the blank spaces on the chart or on available tracks at the east end of the freight-house.

These 130 cars average from 15,000 to 20,000 pieces of merchandise daily. A careful record shows that the mistakes in loading amount at most to one-tenth of 1 per cent., or about 15 out of the 15,000 to 20,000 pieces handled. This is quite remarkable in view of the fact that merchandise received at Wood Street comes out of foreign cars indiscriminately instead of as at freight-houses used by the public where it is delivered at the most convenient door by a teamster who knows the arrangement of the house and the destination of his goods and who keeps his shipments separate for loading.

At 5 p. m. the boxes are taken out of the loaded cars, the doors are closed and sealed, and the cars are ready for the road. The connecting line cars are closed at 6 p. m. In addition to the road cars loaded in the house, solid cars loaded on near-by team tracks go out of Wood Street.

An unique method of instructing illiterate truckers is successfully employed on the Panama Railroad. The truckers are of all nationalities. Ninety per cent. of them cannot read nor write but none are color-blind. At each terminal the steamship line and the railroad have checkers. A negro works with them calling freight, and, when traffic does not run heavily, he also marks it. He has a tin tray, a brush, holders, and a number of small pots containing paints of different colors. A truck comes up containing a box for a certain destination, Callæ, for instance—and a stroke of yellow and one of green is applied. The trucker proceeds to the car on which a placard is hung with corresponding colors. A package going into the wrong car will show whether the painter or car stower made the error. At Balboa, crayons are being tried instead of oil paints.

In unloading freight, the waybill check or blind tally may be used. Each method has its adherents. In the waybill check, the tallyman checks off each package or lot of packages opposite the waybill entry for same. It is possible of course, for a careless checker to mark off packages or items for which the freight is not at hand, or to check off items mechanically before the freight is unloaded. In the blind tally, the tallyman uses a blank sheet upon which he enters the marks of all packages taken out of the car. The waybills are afterward checked with the sheet. A little more labor is involved, but those who favor this method claim that it insures a closer check than that afforded by the waybill check.

The practice as to weighing package freight differs. At some stations all shipments are weighed; at some stations it is the practice to weigh occasional or suspicious shipments, or those from shippers known to be unscrupulous; at other stations weighing is done spasmodically; at still other points there is practically no weighing done. Packages of known weight, such as flour in barrels, sugar, coffee, are seldom weighed. Weighing adds to the cost of handling and tends to delay shipments, but it should, nevertheless, be done, except in the case of standard packages of known weight. At a western freight-house, where package freight had not been weighed, it was found the estimated weights were nearly 20 per cent. too low. The loss to the road was enormous. The tendency of the times backed up by the policies of the Interstate Commerce Commission is to weigh all freight. The general question is fully discussed in Chapter XIV.

The ordinary process of handling inbound package, or l.c.l. freight-house is to place the cars opposite the house, unload the freight, and truck it either to teams direct or to the proper section of the house. Bulk or car-load freight is handled on team tracks direct from cars to teams or vice versa. The usual practice is to first unload perishable freight, i.e., market produce, butter, eggs, etc. This is accomplished, as a rule, between 6 and 7 o'clock in the morning. The house is generally divided into sections alphabetically. The teamster hauling John Smith's freight will, for instance, go to the door nearest section "S." In some cases his freight when unloaded is placed in the section nearest the car. This saves house trucking, but requires the teamster to go to different doors, and frequently to several doors, for one load.

He then locates his freight by the information given on the freight receipt or at the cashier's office, where he pays the freight bill. In unloading from the car the freight is usually compared with the waybills accompanying it, checked, and shortages, overcharges, or damage noted. When the teamster gets his freight he receipts for it to the delivery clerk.

Outbound freight is delivered at a certain door, the number of which indicates the destination. Large shipping concerns are usually furnished with a house lay-out, showing door numbers for different destinations. In this manner the hand-trucking distance from the team to the car is reduced and much cross-trucking in the house avoided. The receiving clerk signs the delivery receipt, which is the bill-of-lading. As the freight is loaded into the car it is checked, and from this check-slip it is billed out at the agent's office; that is, the waybill is made. After the cars are loaded they are sealed with the station seals, the numbers thereon showing where the car was loaded. A side-card is placed on each side of the car giving point of shipment, destination, car number and initial, weight and route, for the guidance of the yardmaster and conductors. The regular waybills which show additionally the rates, amounts prepaid or to be collected, names of shipper and consignee, are usually mailed to the delivering agent or the transfer station direct and forwarded by passenger train.

The National Industrial Traffic League, in April, 1907, distributed a circular among its members, containing this good advice about marking freight:

> "We desire to call special attention to the vital importance of having all packages of freight for less than car-load shipments legibly marked and so marked as not to be obliterated by the ordinary risks of transportation.
>
> "When necessary to use tags for marking, they should be strong and durable, made of rope manila, paper or linen, preferably the latter, and should be either sewed securely to the package or tied to it by a wire tie.
>
> Also dray tickets and bills-of-lading should be made out in a clear and legible manner. Examination of the files at railway stations shows that excessive carelessness exists in this regard in very many firms, the shipping tickets being made out in the most slipshod fashion, so that in very many cases billing clerks must guess at name of consignee, destination and articles.
>
> "We are making complaint to the railways regarding the incomplete and sometimes illegible character of expense bills. . . . . . We certainly cannot expect this reform to be accomplished unless we do our own part." . . . . .

One of the troubles in a freight station is the enormous amount of impatient telephoning of inquiries regarding freight arrivals. This has been successfully met in the Toronto office of the Canadian Pacific, where the clerk at the telephone has constantly before him copies of the arrival notices made out for each consignee on the arrival of freight, and, these being suitably assorted alphabetically, he can usually answer a telephone inquiry from any person or firm in 20 seconds or less. The notices are classified, not only under each letter of the alphabet, but also, when necessary, by subdivisions under each letter.

When waybills arrive, the clerk who makes the expense bills uses carbon sheets and makes four copies at one writing. One of these copies, the "No. 4," which is called the office record, is handed at once to the clerk in charge of the cabinet at the telephone, who assorts all of the sheets received and puts them in the proper pigeon-holes. Then, on receipt of an inquiry, for example, from the T. Eaton Company, as quickly as the clerk can turn and catch the letter "E" on the horizontal line, Fig. 165, and letter "A" on the perpendicular line, he is enabled immediately to locate the proper pigeon-hole and get the necessary information. The "No. 4" being a carbon of the "No. 1," all information as to date of arrival, date of shipment, number and kind of packages, weight and charges, are right before him, so that all questions relating to the shipment can be answered intelligently. In the event of goods not being in and consignee wishing to be advised by phone when they do arrive, a pink slip is used; the information being inserted in it as to date shipped, kind and quantity of goods and the consignee's phone number. This "pink" also serves the purpose of a directory for keeping track of inquiries made by transient persons when, together with the information above referred to, the street address is also inserted. When the goods finally arrive and the No. 4's are being distributed into their proper places, if a "pink" is discovered in a pigeon-hole, the consignee is immediately notified.

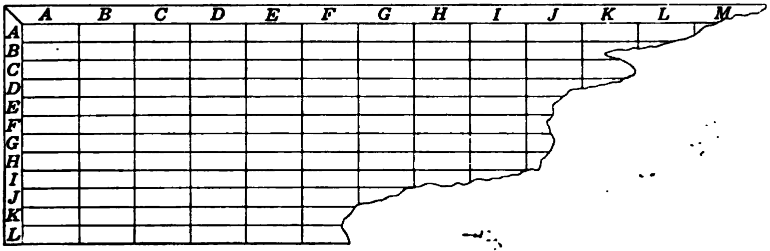


FIG. 165.—Cabinet for holding freight arrival records.

The same consignee may phone, "when will our goods be delivered?" This may be answered as quickly as any of the other questions. When the delivery clerk passes over the sheets to the cartage company the "No. 3" is retained for the accounting department, but before these are passed to that department the inquiry clerk takes them and in spare moments takes out the corresponding "No. 4" and places it in the "Z" space at the bottom. All he then has to do when he fails to find a "No.4" in its proper place is to look in "Z" and he is then in a position to know whether the shipment has passed out and is on its road for delivery.

At the close of the day the "Z's" are taken out, tied together, dated, and sent to the record room. If taken from one pigeon-hole after another in regular order, they will be found when tied in alphabetical order.

If a consignee has inquired several times and it seems desirable to start a tracer, the "pink" with the information obtained at the time of the first call, is still in the pigeon-hole and is available for quickly making a memorandum which can be handed to the tracing clerk, thus saving the consignee all unnecessary trouble.

The work in the freight-house includes that very large ingredient, the O. S. & D. (over, short and damage) clerical tracing either independently or in conjunction with and for the general freight-claim department. Unfortunately there is a growing tendency to handle or trace claims in a most perfunctory manner. This is largely due to the lack of initiative or ingenuity displayed by the claim offices, and the ease with which they fall into the way of doing the work in a routine manner.

In Chapter XXI, the store-door delivery system of the railways of Great Britain is described. This method can be worked to advantage in many large freight terminals in this country, particularly where houses are frequently congested, because teamsters haul spasmodically or irregularly, being easily affected by weather conditions or opportunities to obtain more remunerative employment for a brief period of time. The freight-house, they argue, can wait. In Baltimore, Washington and Philadelphia, the Pennsylvania and Baltimore and Ohio railroads have already undertaken their own draying by either operating the cartage companies direct or by contracting with them. The usual rate is from 1 to 3 cents a hundred weight at each terminal, the cost being included in the freight rate.

In Montreal, the Grand Trunk railway delivers and receives freight at the shipper's door, having a contract with a cartage company for that purpose. The system was evidently introduced because it was an English custom. The city is divided into zones for cartage purpose, to adjust the rates equitably. The cartage company receives an average of 60 cents per ton, of which 40 cents is recollected from the shipper, the railway losing the remainder. For instance; a package weighing 500 lb., on which the freight is 20 cents per hundred would be billed at 22 cents, or $1.10 for the shipment. The cartage company signs bills-of-lading for such freight as it collects and is responsible for it until delivered to the railway company at the freight-house; and it receipts to the railway for inbound freight and assumes responsibility for it between the freight-house and consigner's place of business.

The arrangement used by the Grand Trunk, the Canadian Pacific and the Canadian Northern in Toronto, is similar. As in Montreal, the cartage only applies to the first five classes. The rate charged shipper is 2 cents per hundred, with a 15-cent minimum. The cartage company receives 2.5 cents and 15 cents for small packages. The railway wins out in keeping its freight-houses cleaned up. The cartage company is under obligation to furnish enough teams to keep freight moving rapidly from the houses; when short they immediately employ outside teams to assist, for which they usually pay $3.50 per day, and it is estimated each team will, under the rates in effect, earn five to six dollars per day.

CHAPTER XXVI

REFRIGERATING, VENTILATING AND HEATING

The supply of ice annually used by railroads is enormous. It is required for cooling drinking-water in depots, offices, shops, passenger cars and for icing refrigerator cars in transit. Independence of local or outside ice companies is essential. Unless manufactured ice is used, it is desirable to locate storage houses and icing plants on lakes or ponds and reship to consuming points as may be necessary. Care should be taken to locate the storage buildings where they will not interfere with future railroad development. Preferably locations should be at the source of supply, arranged to enable trains to pull away from and stand clear of the main tracks while being iced.

A supply of ice for two water coolers in each passenger coach, sleeper or chair car, will require from 30 to 40 lb. for each car. This lasts about 16 hours in summer and about 24 hours in winter—although the ice in heated cars will melt nearly as rapidly in winter as in summer. From 1000 to 4200 lb. is needed to charge a refrigerator car for a run of two days to a week, depending upon temperature and whether car is in motion or standing. At small stations, 30 lb. per day is required; at large stations, 75 to 125 lb. Shops will use from 200 to 1000 lb., according to number of men employed.

In computing ice storage capacity, allowance must be made for shrinkage. In brick or concrete houses, this will run about 10 per cent. In well-constructed frame houses it will be slightly more. Shrinkage in large houses is less than in small ones. If natural ice is depended on, short or missing crops must be considered.

In figuring on capacities and consumption, a cubic foot of sea-water ice weighs 64 lb.; rain water ice 62.3 lb. and pure solid ice averages 58.7 lb. On the basis of 58.7 lb., 34 cu. ft. are equivalent to a ton of 2000 lb.; or 38.25 cu. ft. to a ton of 2240 lb. Ice is usually assumed to weigh 60 lb. per cubic foot, making 33.3 cu. ft. to a ton of 2000 lb. Allowing for voids and irregular packing, 36 cu. ft. will be a better figure for estimates.

In construction of ice houses or storage of ice, non-heat conducting walls are essential. There should also be ample ventilation on top of ice, good drainage at the bed, and proper appliances and arrangements for handling and stocking the ice economically. The best-designed houses have walls with air spaces, or spaces filled with sawdust, shavings, ashes, or other non-heat conducting material. Less heat will be absorbed if outside of building is painted a light color or whitewashed. Sawdust or salt hay are good materials for covering top of ice, to prevent contact with air.

Refrigeration plants are very generally used. Ice can, in many instances, be manufactured and sold cheaper than it can be harvested, stored and then transported to market. Mechanical refrigerator cars are used to a very limited extent and have not been generally adopted, because of high first cost, the complicated arrangement, and the care necessary for their successful operation. Stationary refrigeration plants require much supervision; and as the time of service is of short duration, the railroads have generally left their construction and operation to shippers. Refrigeration is used only for transportation of fruit, vegetables and meats, freight which is essentially seasonable in character. Perishable products are transported with ventilation or icing, or a combination of the two. Bananas require a mean temperature of 68°; other fruits require temperatures ranging from 34 to normal. Meats are often frozen.

Pre-cooling plants for handling fruits—especially bananas—are almost indispensable on roads with heavy traffic of that character, and several have been constructed. In one type of these stations, large quantities of air are cooled by being carried over cold brine or ammonia piping and are then conveyed through troughs to the train shed, where they are injected through canvas ducts into as many as 50 cars at a time. The desired temperature is obtained in a few hours. Ice is objectionable because of the moisture it creates.

A pre-cooling plant of the Southern Pacific Co., at Roseville, Calif., for cooling oranges for shipment is shown in Figs. 166 and 167. Cold air is blown through a large insulated tube leading from a bunker room in the storage plant to the ice trap in one end of the car. From a trap at the opposite end of the car, another tube leads back to the warehouse. The method by which connections are made with the cars is clearly shown in one of the views. The cold air is blown into the car at a temperature of 32°, and after passing through the car is drawn back by an exhaust fan to the warehouse, where the moisture and gases from the fruit are frozen on the refrigerator pipes. The direction of the current through the car can be changed. With a powerful air current, it takes from 30 to 50 hours to cool the fruit in the center of the packages to 40°.

A large cold storage plant operated on the same principle has been built at Springfield, Mo., by the St. Louis & San Francisco, to cool bananas in cars in transit. This plant consists of four tracks inside a shed, each track holding ten cars. The same plant may be used in winter to raise the temperature of the fruit when desired.

A ground plan is shown in Fig. 168 of the Southern Pacific's pre-cooling plant at Colton—an ice-making plant with pre-cooling building at each end, a track in each side and connections for 40 cars.

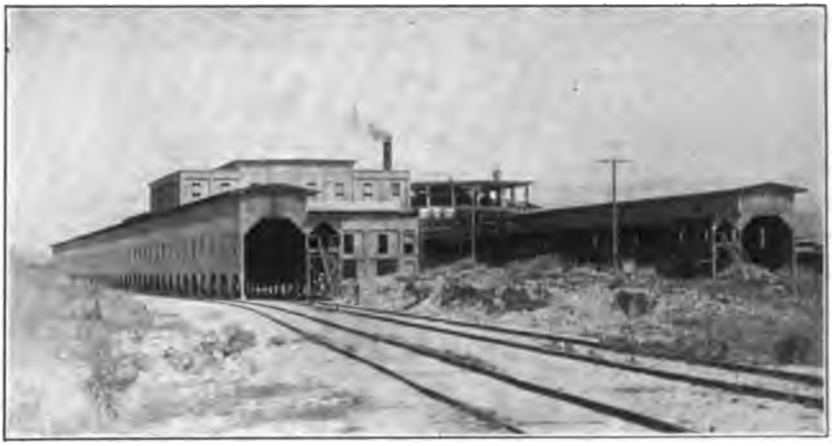


Fig. 166.—General view, pre-cooling plant, Roseville, Cal.—Southern Pacific.

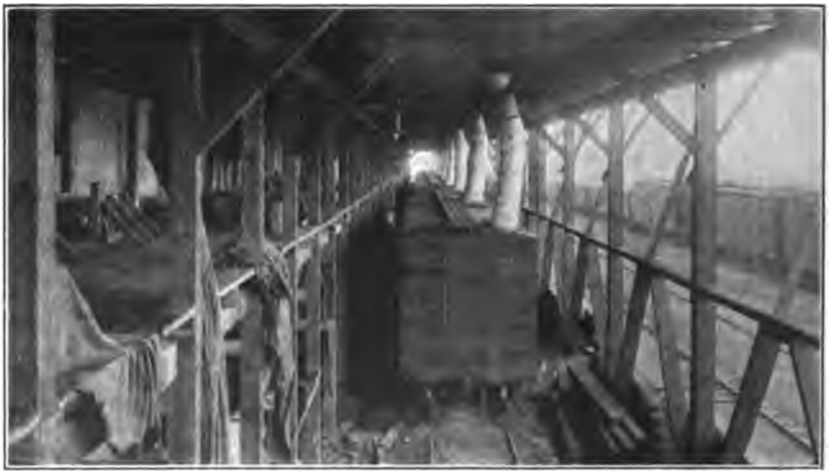


Fig. 167.—Roseville pre-cooling plant in operation.

The pre-cooling buildings, 43 ft. 4 in. × 121 ft., are built of reinforced concrete. The mechanical equipment is carefully arranged and includes the exhaust fans, which are motor-driven, the flexible piping, the brine coils around which the air is passed and which are therefore enclosed in an air-tight chamber. The details of the false door, through which the cold air is forced into the car, are shown in Fig. 169.

In the vertical section, a deflector will be seen, placed opposite the mouth of the pipe, to throw the air current upward. The fruit is so packed as to leave an open space at the top of the car opposite the door, and in this space a special deflecting device is placed during cooling, to direct the air currents among the boxes of fruit.

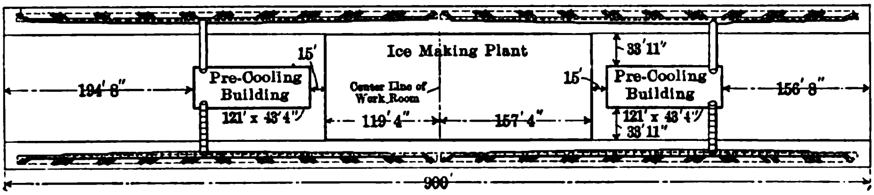


FIG. 168.—Ground plan, pre-cooling plant, Colton, Cal.—Southern Pacific.

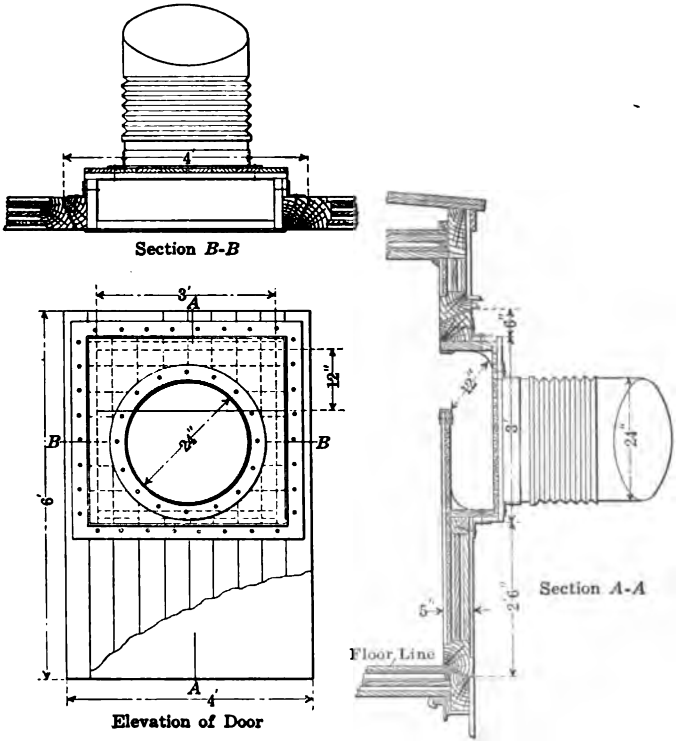


FIG. 169.—Details of false door, pre-cooling plant, Colton, Cal.—Southern Pacific.

A combined ventilating, heating and refrigerating car has been developed and is said to be fairly successful. Exhaust ventilators on the roof of the car, operated and adjusted by levers on the roof, together with reversible hoods at each end of car, control the ventilating features. Heating is accomplished by steam pipes connected to the locomotive, or a yard steam plug, in much the same manner as passenger cars are heated and kept warm. The usual refrigeration methods are employed; ice tanks are placed in each end of car with hatch openings, plugs and hatch covers.

A refrigerator car using methyl chloride has been introduced in Germany. It contains an individual refrigerating plant, using methyl chloride as an agent. The car is covered with a non-conducting material. At one end a small compartment is partitioned off in which a compressor is placed, driven by belts from the axle.

Methyl chloride is used because it can be volatilized at a low pressure, does not affect the copper pipes and does not have as disagreeable an odor as ammonia or sulphuric acid. While the car is in motion the compressor sucks the gas from the condensing coil, which is attached to the roof of the car, and forces it through a water tank into the condenser below the car, which is supplied with a collector for the liquid methyl chloride. From there it is admitted into the cooling coils. Valves regulate the temperature of the gas in entering and leaving the cooling coil and also make it possible that only dry, saturated gas is provided for the compressors. The arrangement of the collectors for the liquid methyl chloride between condenser and cooling coils, renders the cooling of the car independent of the motion of the compressor, especially when the car is not in motion.

Refrigeration of freight in transit is affected by speed. At 25 miles per hour and an external temperature of 68°, it is claimed that the interior of the car can be brought down to 32° or freezing, in from 40 to 50 minutes.

Few roads have any systematic method for the preservation of perishable freight while in transit. There is considerable variation in the temperature at which different commodities of a perishable nature are liable to damage, and they may be further affected by their condition when shipped, time in transit, time continually in motion, etc. With the use of the modern car there is no good reason for permitting freight to become frozen. It is only during extreme winter weather that the use of the heater car becomes necessary. If produce has been exposed to low temperature for some time before being placed in a car, it is not in a condition to withstand cold. A car of produce, such as potatoes, will in all probability stand a lower temperature when the car is in motion than when at rest. With the outside temperature at 20°, perishable goods may be safely shipped in ordinary freight cars and in refrigerator cars down as low as 10° above zero. It is further claimed that these goods may be safely shipped in refrigerator cars with the temperature nearly 10° below zero, if the car is heated before being loaded and the goods, at the end of the trip, are immediately taken to a warm place without being handled any great distance in a dray. In the best refrigerator cars, perishable goods may be safely handled with the temperature as low as 20° below zero, provided they are not subjected to such cold for more than three or four days at a time; with the ordinary refrigerator cars the most perishable goods are liable to be damaged in zero weather. Before shipping fresh beef, it should be chilled to 36°, although 40° will suffice under favorable conditions. It is considered important that the beef be kept at a uniform temperature from the time it is started until it reaches its destination, and the cars should therefore be at the same temperature as the chill rooms. In summer, cars need re-icing frequently to maintain the proper temperature and no fixed rule can be established as to time or distance between re-icings, this being governed by the outside temperature.

Heating cars by using ice has some possibilities, and the Government Weather Bureau has given the question consideration. A car has been designed that is to use ice with salt, in summer for the protection of perishable goods in transit and the same car is to be iced in winter to prevent freezing. This is on the theory that ice, which is normal at 32° Fahr., absorbs heat at a higher temperature, and imparts heat at a lower temperature. Hence, when it is zero weather outside, the ice containers in a car act as stoves, helping to keep up the temperature inside. Another method for protection against freezing consists in throwing a stream of water on the car when the thermometer is near the zero point. The water freezes and forms a complete coat all over the outside of the car. This prevents the warmer air from coming out of the car and so tends to keep up the temperature inside. This is particularly advantageous in the transportation of bananas, which are quite susceptible to cold. Fruit of this kind is put in paper bags inside of heavy canvas bags and covered with salt hay when the temperature is dangerously low. No theory has, as yet, been suggested to account for the interesting phenomenon that perishable produce, such as fruit and vegetables, will stand a lower temperature when the car is in motion than when it is at rest.

The use of paper for protection against cold is increasing and its effectiveness is wonderful. Fruit wrapped in heavy brown paper will endure 15° more cold than without it. Potatoes are sometimes packed in barrels lined with paper, and when the weather is unusually severe the barrels are also covered with paper. Clams and oysters are similarly shipped in paper-lined barrels to keep them from freezing and cars for transporting perishable merchandise are quite commonly lined with paper. There is said to be nothing like it to keep out frost. Eggs shipped in crates with separate pasteboard divisions and covered with a layer of oat chaff will stand a low temperature. It is found that pickled eggs are injured by cold more quickly than fresh ones.

Fruit products in cans or glass must not be shipped when the temperature is below freezing. A well-ventilated dry cellar is the best place to store apples, potatoes and vegetables generally, the temperature being from 30 to 45°. Apples are not made unfit for use by freezing, if they are allowed to thaw gradually. Tropical fruits in storage should be kept at from 60 to 70°.

Mineral waters exposed to a temperature below 30° soon spoil. Beer may be shipped with the outside temperature at 10° if the kegs are packed in hay or sawdust and fresh stable manure. Butter freezes at 15° and when thawed it quickly becomes strong. Milk should never be allowed to freeze. Pork is injured more quickly by high temperature than other meats.

Instructions as to icing and re-icing cars containing perishable freight and handling icing plants are usually as follows:

1. Regular shippers of dressed beef, provisions, etc., will be advised by the Traffic Department that, if they desire cars iced, they must note on their shipping tickets at Chicago or other western points (which will be carried forward on the regular or card manifests), "Ice at ——."

2. No cars containing dressed beef, provisions, or other perishable freight, should be iced at that station unless the waybills or card manifests bear the notation, "Ice at ——," or unless ordered by a proper officer of this Company in case of emergency.

3. Agents at receiving stations and junction points will wire direct to the agent at —— the number of cars requiring ice at —— that each different beef company has on the various trains leaving their stations. The agent at —— will keep himself advised by wire as to the probable time of arrival of such trains at the icing station.

4. The agent, yardmaster and conductors will be responsible for the prompt placing and handling of refrigerator cars at the icing station, and must be thoroughly familiar with the schedules to be maintained.

5. The agent will see that the foreman of the icing station ices cars without unnecessary delay after they are placed, and will use sufficient ice to protect the lading according to the character of the freight and the service to be performed, making proper allowance for any probable delays in movement and delivery, and care should be taken not to use any unnecessary quantity of ice.

6. A record must be kept by the foreman of the icing station of the estimated weight of ice in the boxes on the arrival of each car at the icing station; also the condition of the waste-pipes, temperature of car, and condition of lading, if the car is not sealed, together with a record of the time of arrival and departure of the car at the icing station.

7. The foreman in charge will be held personally responsible for seeing that the ice already in the tanks of refrigerator cars on arrival at the icing station is properly tamped down with poles before any more ice is put in. Great care should be exercised to see that the waste-pipes are properly rodded and running freely. Before putting ice in the boxes, the ice (either in blocks or crushed as directed) should be thoroughly cleaned. Wooden tamping-sticks only should

be used. Do not use hooks or other pointed tools in tamping or shifting ice in the tanks.

8. The foreman at the icing station will accept direct advices from the shippers as to the quantity of salt they want used in icing their cars, as different shippers have different ideas on this subject.

9. With instructions to use salt and no definite instructions as to the amount, spread uniformly on top of ice not less than 9 lb. of salt to 100 lb. of ice used.

10. Use coarse rock-salt if obtainable; if not, common barrel salt. Do not use salt at all if instructions on waybills or conductors' tickets bear notation that no salt is to be used.

11. The regular charge for ice, labor and salt is at the rate of $2.50 per net ton for the actual amount of ice put in each car.

12. A complete and accurate report of the weight of ice used for each car must be kept by the foreman; and bills for icing must be rendered monthly by the agent to, and collected through, the comptroller.

13. The agent will give monthly credit for the icing charges to such firms as may be designated from time to time by the comptroller.

14. When refrigerator cars loaded with perishable freight are wrecked, or shopped for repairs, or exceptionally delayed from other causes, the ice-boxes of the car containing the lading should be examined, and, if necessary, re-iced before such cars are forwarded; and if the lading is transferred, the car into which it is transferred should be previously chilled and fully iced, and report made by wire to the division superintendent, comptroller, and the freight traffic manager as called for by general manager's circular.

15. When cars are iced for firms other than regular shippers to whom credit is authorized by the comptroller, the agent at —— will expense upon the delivering agent for the cost of re-icing, waybill to accompany the car, and amount to be collected from consignee or connecting road upon delivery.

Transferring dressed beef in case of accident is ordinarily handled under instructions similar to the following:

First, wire the division superintendent, giving the initials and numbers of the cars damaged, and state whether the contents of all the cars will have to be transferred, and how many refrigerator cars are required for that purpose.

Second, wire the freight traffic manager, giving the same information, and, in addition, the name of the shipper, the point of origin and the destination of the property.

Refrigerator cars in good order and well iced must be secured and taken to the place of wreck.

It must be remembered that fresh beef when exposed to the air, or if transferred into cars that have not been previously cleaned and iced, will spoil.

Great care should be taken to keep the beef out of the dirt, and when handled from one place to another must be carried, and not thrown.

Boxed meats are usually loaded in the center of the car, and are to be taken out and placed aside until the other car is ready to receive them.

Hang the hind-quarters at one end of the car, on short hooks, shanks up, and closely together, putting insides to insides and skin sides to skin sides, etc.

Hang the fore-quarters at the other end of car, on long two-pronged hooks, neck end down, and see that hooks are placed in the same holes as before. Hang the fore-quarters same as the hinds; insides to insides, etc.

When no hooks are available, small hide or other rope may be used, being particular to string the beef through same holes that the hooks were in.

Dressed calves, sheep and hogs should also be hung up, and may be put in any unoccupied place.

Throw the livers away, as they will spoil after exposure to the air.

Remove meat hook and rack equipment from disabled car along with the beef.

Advise the division superintendent and the freight traffic manager by wire, numbers of the cars into which transfer is made, and the time they are forwarded.

Proper manner of re-icing refrigerator cars, as directed by one operating company is as follows:

1. *Ice.*—All that is to be used in icing cars of this line must be washed clean; it must be free from hay, straw or sawdust. *This is very important.*

2. *Breaking Ice.*—Before the ice is put into the tanks or receptacles, it must be broken up in small pieces—the largest piece to be not larger than a man's fist. The ice *must not* be broken on the roofs of cars.

3. *Icing.*—Before putting new ice in the tanks of cars, the old ice in them must be tamped down solid, using a wooden tamper to tamp the ice—a piece of 2×4 will answer. Great care should be taken to carefully tamp ice in tanks, as the salt used has the effect of honeycombing the ice, giving tanks the appearance of fullness, which in fact does not exist, and there is usually room for more ice after using tamp. Do not use ice hooks or other pointed tools for tamping or shifting ice, after it has been put in the tanks, as by the use of such tools, holes are liable to be punched through the tanks, allowing water to get into the car, which would damage the contents of car.

4. *Salting.*—Cars should be iced with not less than 12 lb. of salt to every 100 lb. of ice used to re-ice car. When car is opened for icing, about one-third (1/3) of the salt should be applied on top of the old ice before the ice is tamped down, distributing the balance of the salt evenly on top of the ice in the tanks after the tanks have been filled. A sharp wooden tamper should then be used to work the salt well into the ice before the covers are replaced. Coarse or rock-salt should be used if possible to obtain; if not, use common barrel salt. The application of salt in the proportion as above stated in icing cars of this line is very *important* and must not be disregarded, for without salt in icing our cars the desired refrigeration cannot be obtained.

5. *Salt.*—Always should be used as per above instructions in icing shipments made in our cars, unless shipments are billed and carded to be re-iced with a greater or less per cent. of salt, in which case please follow the instructions on bills or cards, and if shipments are billed and carded, "Re-ice without salt," please be governed accordingly.

6. *Covers.*—Fill the ice tanks as full as possible, being careful to see that the tank covers are properly replaced before cars are allowed to go forward.

A typical icing station is that of the Burlington at Galesburg. It has a crusher for icing meat cars in addition to arrangements for supplying cake ice for fruit and vegetable cars. The drawings in Figs. 170, 171, 172 and 173 are of the general plan, transverse section, front elevation and wall details, of the plant at Hawthorne, which is similar to that at Galesburg.

The foundation of the house is concrete. The framework is made of 2-in. × 6-in. × 12-in. studding with sawdust packed between and insulated, as shown in the illustrations. Beginning with the outside face of the wall, first there is one layer, or thickness, of house or drop siding, then, in the order given, two layers of heavy insulating paper, one thickness of sheathing boards, a space between the 6-in. studding packed with sawdust, two layers of insulating paper, one thickness of sheathing

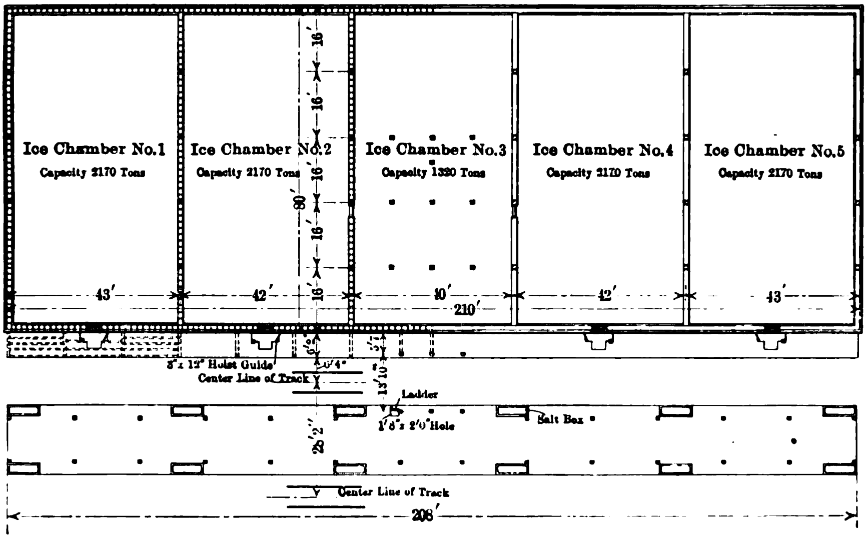


FIG. 170.—General plan, icing station, Hawthorne—Chicago, Burlington & Quincy.

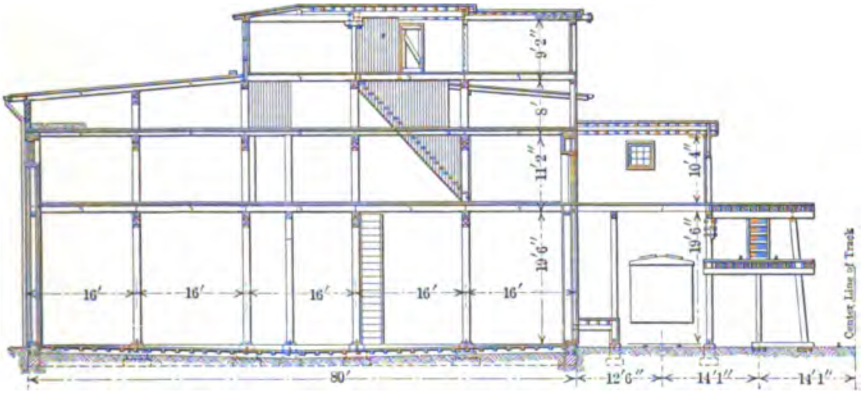


FIG. 171.—Transverse section through ice-crushing room, Hawthorne plant—Chicago, Burlington & Quincy.

boards and a 12-in. dead air space between the 12-in. studding; one thickness of sheathing, two layers of paper, a space between the 2-in. × 2-in. furring strips filled compactly with "Flax Lith" blocks coated on the inside with one coat of cement applied hot; two layers of paper and a finish of one thickness of sheathing boards. The inside walls between the rooms and the ceilings are also insulated and packed with sawdust.

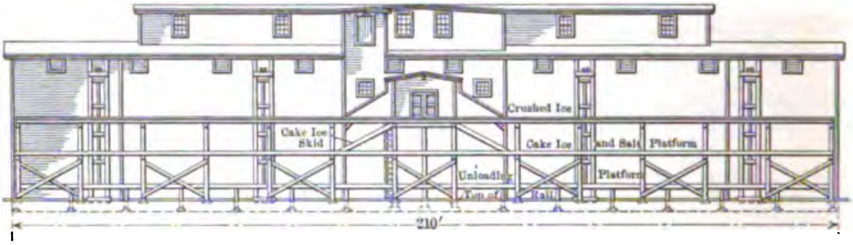
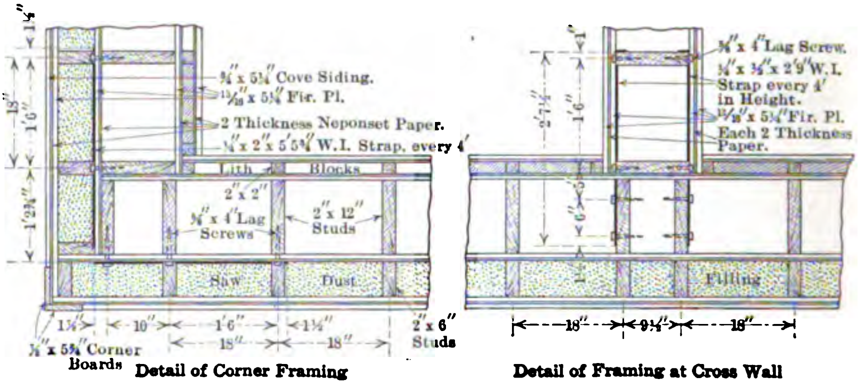


Fig. 172.—Front elevation, icing plant, Hawthorne—Chicago, Burlington & Quincy.

The building is divided into rooms which hold each about 2000 tons of caked ice. A house of 15,000 tons capacity has seven rooms, each of which is equipped with an inside hoist for raising ice to the top of the room, to be run to the crusher room, located over the center room of the house. Hoists are also placed on the outside of the house for filling it with ice. These outside hoists extend from a platform adjoin-



Detail of Corner Framing **Detail of Framing at Cross Wall**

Fig. 173.—Wall details, icing plant, Hawthorne—Chicago, Burlington & Quincy.

ing the house, 4 ft. above the track level, to the top of the house. In filling the house no packing is used, the cakes of ice being laid close together, either on edge or flat, and the rooms filled to within 4 ft. of the top. Records show that during the hottest weather the temperature in the ice chambers is about 35°.

In front of and parallel with the length of the house, is a double-deck icing platform. The upper platform is used for icing cars of fresh meat with crushed ice and the lower one for icing cars of fruit and vegetables with cake ice. There are tracks on both sides of the platform, on which cars are placed while being iced. In icing cars from the upper platform, carts filled with crushed ice are distributed along the platform shortly before a train arrives. When the latter is in position at the platform, the covers of the ice tanks on the cars are removed and the crushed ice emptied from the ice carts into the tanks by means of a spout adjusted on the edge of the platform and which is easily moved from car to car on a trolley rod attached to the platform. A supply of coarse salt used to mix with the crushed ice is kept in boxes placed at intervals on the lower platform and is shoveled into the ice tanks or put into them with pails. The time consumed in re-icing cars with crushed ice and salt is from 1 to 2 minutes to the car. If the station has advance information of the coming of a train for icing, so that all preparations can be made, 50 cars can be supplied with crushed ice in an hour.

The lower platform from which cars are iced with cake ice, is nearly on a level with the top of the cars. The cakes of ice are run on skids from this platform into the tanks of cars.

The crushers and the hoists for filling the house and for raising ice to the crusher room are run by electric motors. The hoists are so connected to the cable drums that they can be operated singly or in sets. Ice can be taken from several rooms at the same time. The outside hoists are operated in the same manner and from the same drums. The hoists are controlled from the carriage and each has a capacity of 30 tons per hour. The crusher has a capacity of 75 tons per hour. The crushed ice is run direct from the crusher into the carts, one of which holds 1000 lb. These carts are on a floor below the crusher on a level with the upper icing platform. Ice taken from the storage room is raised to the top of the rooms and from the hoists is run on skids by gravity direct to the crusher or to the lower icing platform.

The protection of bananas in transit is one of the greatest problems, both because of the susceptibility of this fruit to depreciation and because the shipments are enormous and increasing. Most of this fruit consumed in the United States comes from the West Indies, Central American Republics, Mexico, and South America.

Twenty years ago it was expected that a 50 per cent. loss in transit would result. To-day it is figured out at a half of 1 per cent. The banana boat is now of special construction and unlike any other steamer. In the holds, instead of having room for cargo there are partitions extending from the well of the ship to the deck. Along the beams in each compartment are hundreds of hooks. They are used to sling the bunches of bananas upon, for bananas should not be shipped with one bunch touching another.

The fruit is first picked green by the growers and then brought to the steamers in boats. As each boat load is taken aboard the bunches are placed in the refrigerators and slung on the beam hooks a few inches apart. When every compartment is filled the steamer proceeds on her journey. To every few compartments there is a man in charge whose duty it is to examine the bunches every day and see that they do not get overripe during the voyage. These men have an electric lamp, and crouching on their hands and knees they go from bunch to bunch, examining each carefully to see whether there are any signs of decay. Should a banana bunch show any tendency to become overripe it is at once taken down from its hook and brought out on deck to be consumed by the ship's passengers or crew or else flung overboard. Careful note is made of the place where the bunch was hung and a detailed examination made of the bananas surrounding it, for one overripe bunch in the course of a single night is apt to contaminate others unless a careful watch is kept. The watch on the fruit is redoubled when the ship is nearing its destination, for by this time all the fruit has more or less ripened. The foregoing may prove instructive, as well as interesting, to railway men, in pointing out the needs of this particular fruit, to enable it to reach its market in good condition.

CHAPTER XXVII

THE ENGINE-HOUSE

The limitations of a work of this character do not permit of a discussion of engine-houses ("roundhouses") from the viewpoint of locomotive repairs, beyond a reference to mere running repairs. The aim of this chapter is to describe the uses and abuses of engine-houses as they relate to keeping a road's motive power in service and moving its traffic, with special reference to the location of the engine-house plant in its relation to the road, divisions and terminals; its accessories, such as the coal, ash, water and sand supplies, and the inspection pits, turntables, and "wyes." These accessories are more fully considered in other chapters.

Engine-houses were formerly built to shelter engines. As a rule they are now used only incidentally for shelter and more particularly for making light repairs and for cleaning or washing out locomotives. Engines in active service need not as a rule be housed, although in northern climates it is difficult at times to care for engines properly in the open. Some motive power people figure on providing engine-house capacity for 25 per cent. of the power in service. Small machine shops to care for more extensive repairs are generally annexed and form valuable adjuncts to engine-houses. In the house one or more drop pits should be provided for taking out wheels.

In planning an engine-house, consideration should be given to the number of engines to be cared for, including future possibilities; the materials available for construction purposes; the possibility of future electrification of the whole or part of the line; the climate and topography of the country; and the available property and structures in the immediate neighborhood.

Types of construction may be divided into three general classes: square, rectangular and round.

Square houses, with one or more tracks entering from a ladder controlled by switches, are operated for a small number of engines, with the result that there is little delay because there are no break-downs of turntables or other apparatus which are required in certain types of houses. The square house is exceedingly simple to construct, economical in first cost and durable. The liability of loss from fire is small. The foreman in charge has a good oversight of the layout and can therefore secure good operating results. The track approaches take up considerable land area. Provision for turning engines must be made where necessary.

A plan and cross-section of a typical square engine-house is shown in Fig. 174 representing the Towanda, Pa., house of the Lehigh Valley, an old plant but unique in its utilization of limited ground space lying adjacent and parallel to the main tracks. It is 63 ft.×183 ft. Seven tracks enter the building at an angle of 46 degrees with the front, or entrance side. Tracks are 13 ft. centers on the square, or 18 ft. on the skew, measured along the face of the building.

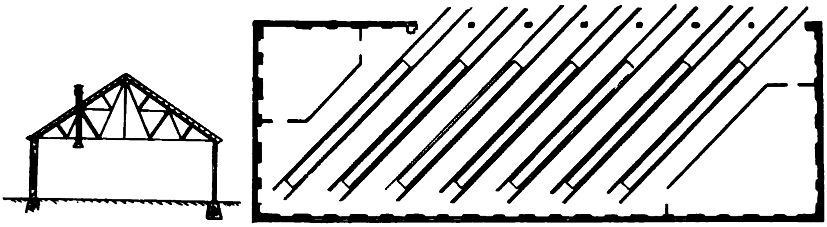


Fig. 174.—Section and plan, square engine house, Towanda, Pa.

The view in Fig. 175 is that of a square engine-house, called "steam-shed" or "running shed" at Crewe (England) on the London & North-Western. It will be seen that engines are housed in tandem and are guided to their respective tracks by switches near the entrances.

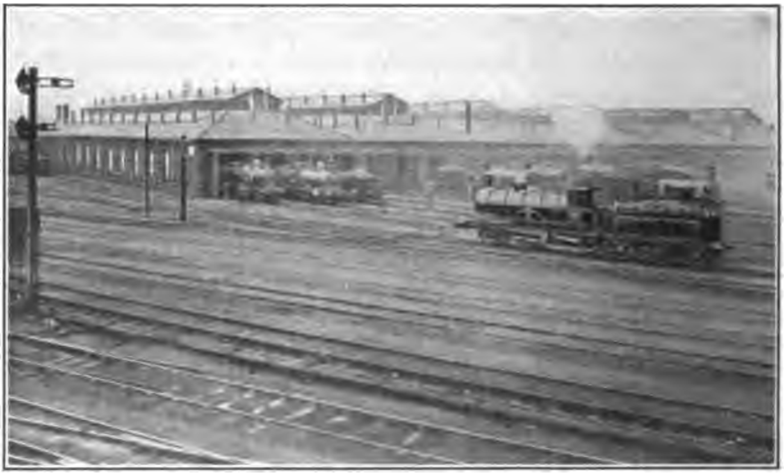


Fig. 175.—Square engine-house, Crewe, England—London and North-Western.

Rectangular houses require the least ground space of any type of construction. Transfer tables are necessary, one of which may serve two houses. These houses are cheap and simple to design and construct.

The oversight is excellent, they afford good light and ventilation, and may readily be extended as business increases. Ample and convenient space is provided for men, machinery and material for making repairs. One house may be built and served by a transfer table and later on a second house added, served by the same table, but a breakdown, derailment of engine or disabling of transfer table is likely to cause serious interference with train movements and in case of fire, blockades may occur with disastrous consequences. In order to minimize this danger, engine-houses of the square and rectangular type have in some instances, been erected with descending grades on the tracks in the house and for some distance from the entrance, to facilitate the removal of engines in case of fire.

Round or polygonal houses require turntables to enable engines to reach or to leave their various stalls. They are economical in land area, as compared with the square houses; they can be well lighted—although this is not always done—and they give the greatest width at head end of engine, where room is most needed for repairs and handling of material. On the other hand, however, they are costly to construct and very complicated both in construction and subsequent operation. The foreman's opportunity for supervision is limited; and a break-down of a turntable, or derailment or disablement of an engine on or near the turntable often causes a bad blockade. These houses make a perfect trap in the event of fire because every locomotive must pass out over the turntable. Houses of this type are usually planned for from 30 to 60 engines for the complete circle, but are often constructed as a segment of a circle because the shape of available land does not permit the full circle or because the present requirement does not demand it. In the latter case it is easy to add to the capacity of the house if the land is available.

In the engine-house, with a turntable entrance, there are three arrangements of tracks in general use, as follows:

1. Omission of frogs altogether, arranging outside of each rail to lie close alongside or just touching the rail of adjacent track at edge of turntable pit. This is by far the most satisfactory method from a maintenance of roadway standpoint. The table must be long enough to permit of this arrangement of tracks, which in itself seems sufficient argument for long tables. Thirty-six frogs represent an investment of about $800, besides the cost of maintenance and adjustment. Tracks should leave table pit at 180 degrees angle, so they will match up at both ends in every case.

2. Running the two rails together to form a point at the edge of the pit, similar to frog construction—in other words to form a frog without the wing rails. This permits—or compels—the use of a shorter table.

3. Adjustment of tracks to suit the selected angle for stalls, putting in

frogs wherever a rail crosses another and if necessary, introducing crotch frogs. The design must be carefully planned in this case, so that the dead ends of rails around the turntable coping can be accommodated without interfering with each other and so that the frog point nearest the pit is sufficiently distant from the pit to permit the frog to be put in and held securely to its place.

The width of the house to be constructed is determined by the length of the largest engine in service, with ample allowance to swing doors inwardly, if they are to be hung that way, and ample passageway width at the head end of the engine, along the inside of outer walls. As a heavy engine of modern design is [1]78 ft. long, over all, the distance, clear, between the inner and outer walls should be 92 or 94 ft., which will leave a space of 7 or 8 ft. at each end, as passageways.

Some houses are planned for engines to be backed in, standing with the front end toward the turntable-pit. Aside from having the engine in position to head out and toward the table when required for service, there seems to be little in favor of this arrangement. It is decidedly better to have the head end, with the machinery part, nearer the outside wall, with the advantage of light, room, machinery, etc., for making repairs.

Much of the loss of engine service is likely to occur at the engine-house and its tributary plants. A careful record was kept of one engine for 30 days, showing that it was held at engine-house (waiting to get over ash-pit, cleaning fires, coaling, watering, in for repairs and minor delays) 22.6 per cent. of the entire time; in actual road-running service, 28.7 per cent.; delay on account not steaming, hot boxes, trouble with drawbars and brakes, 1.9 per cent., while the remainder of the time—46.8 per cent.—was chargeable to the following items, in order of amount of time consumed: Switching, wrecks, trains ahead, orders, cleaning fires on road, coal and water on road, waiting orders at engine-house, yards blocked, passing trains, and sundry small delays.

A typical engine-house layout, with the usual facilities, is that at Jackson Junction, Mich., on the Michigan Central, shown in plan in Fig. 176.

Ash-pit tracks Nos. 1 and 2, run to the turntable direct. The approach of the depressed track for ash cars is laid on a 2 per cent. grade. The coal elevator has a capacity of 500 tons.

The sanding boxes are placed on the corner of the coal elevator adjoining the ash-pit tracks, on the corner of the sand house proper. The sanding is done by means of drop pipes handled by hostlers, the time for filling the largest boxes being about 15 seconds. The sand house is equipped with three stove dryers; sand is elevated into sanding boxes by means of compressed air. Storage is provided for about 12 car loads of wet sand, which is unloaded from cars placed on the sand house and storing tracks. The sanding box on ash-pit track 2 is large, having a capacity of about 10 cu. yd. and out of this box sand needed for outside points is loaded by means of a drop spout or chute into cars placed on the sand house track. Nine or 10 yards of sand can be loaded in this way in a few moments.

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[1] The articulated (Mallet) type is often 88-ft. long. One built by the Baldwin Locomotive Co., for the Pennsylvania is 88 ft. 2 in, engine and tender, with a total engine wheel base of 57 ft. 5 in. The largest in service is an articulated compound on the Santa Fe 108 ft. 1.5 in, with engine wheel base of 66 ft. 5 in.

Each of the ash-pit tracks is provided with a 10-in. water column and tenders are filled very quickly, the filling of tenders being the last operation before engines are put on the turntable. This is not as the plant was planned, it being intended that the knocking out of the fire should be the last operation, but conditions of space made that impracticable.

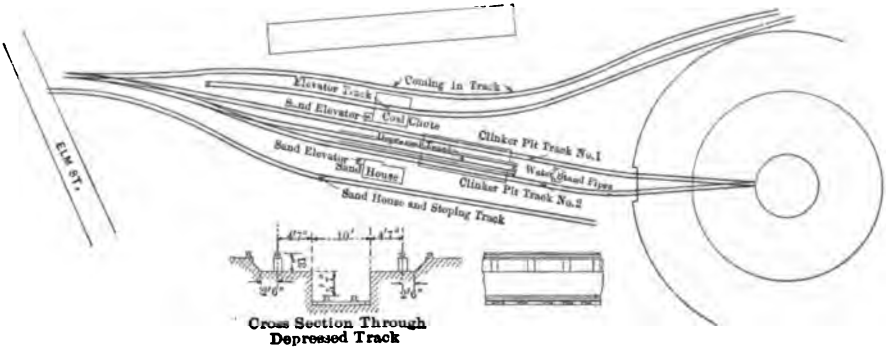

FIG. 176.—Typical engine-house lay-out, Jackson Junction, Mich.—Michigan Central.

The cross-section of the ash-pit track shows the general plan, the inner rail supported on cast-iron piers jacketed with No. 10 iron, the remaining space on the inside filled with concrete, tie rods at 10-ft. spaces provided along the open space of the ash tracks to prevent possibility of rails spreading. The ash pits and depressed track are of solid concrete and good drainage is provided. Two hydrants are arranged on each ash track for wetting cinders, and a steam pipe is provided for thawing out ash pans and grates when that is needed.

Engines arriving off the road are left on the "coming-in track." When they arrive in quick succession, as is the rule in winter or during seasons of heavy traffic, no attempt is made to coal all on the north side of the elevator, hostlers usually alternating, that is, one is coaled on the north side and the next on the south side, or if necessary, several engines are taken off of the coming-in track at once and coaled on ash-pit track 1.

In this way it will be observed that when, for example, it is necessary to get hold of the sixth engine in the line, the first five engines can be taken at once on the ash-pit track 1, and the engine that is most desired can then be coaled on the coming-in track, after which it can be taken around onto ash-pit track 2, sanded, fire cleaned, watered and housed, in from 15 to 25 minutes from the time of its arrival.

There are six hostlers regularly employed, and six ash-pit men, three of each for the day and night shifts respectively, and 100 engines are handled in 24 hours without difficulty.

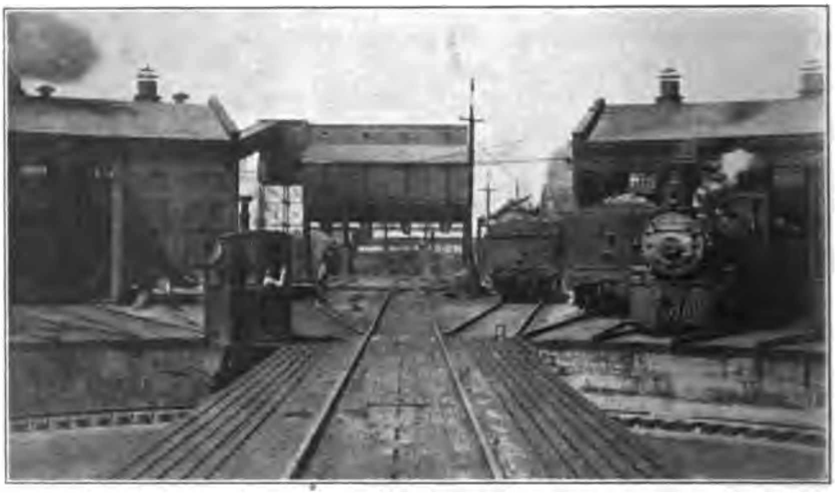

FIG. 177.—Engine-house, showing coaling-plant portion, Allegheny, Pa.—Pennsylvania Railroad.

In addition to the duty of cleaning fires, the ash-pit men also attend the switches at the west end, unload the green sand, run the dryers, elevate the dry sand to the sanding boxes, attend to water columns, and shovel the ashes on the cars on the depressed track.

For the coal elevator there is one elevator man, one dumper and one loader for each of the day and night shifts, or seven men all told, including the fuel foreman.

The two views of the Allegheny engine-house of the Pennsylvania, Figs. 177 and 178 show a well-arranged house with its attendant facilities. One is a view of the coaling plant from the turntable pit; the other is a bird's-eye view of the whole plant.

The plan which a Committee of the Master Mechanics' Association recommends is shown in Fig. 179. It provides a set of tracks upon which incoming engines can be spotted by the road crew, where they are left until the hostlers take them out for coaling, cleaning fires and housing.

The object of the spot tracks is to permit the last engine to be the first one housed, if such is desired. This plan, it will be noted, requires much space, longitudinally. It could not, therefore, be utilized at all points.

The Association makes the following general recommendations relative to the facilities an engine-house should have:

"1. What is known in the yard language as a 'spot'—a system of tracks connected to the inbound track in the yard, also connected to the main coal track leading to the roundhouse table; this system of tracks to be so designed as to enable at least 10 engines to be delivered by inbound engine crews, any one of which can be moved to the coal chute, in preference to the other nine, at any time.

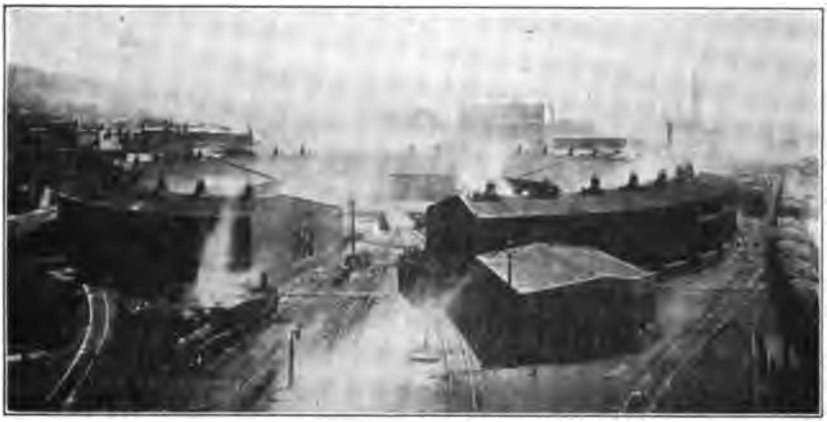

FIG. 178.—Bird's-eye view of engine-house, Allegheny, Pa.—Pennsylvania Railroad.

"2. An outbound 'spot' track and a water crane, so that outbound engines may take a full tank of water just before leaving; also water cranes so that inbound engines may take water immediately after taking coal.

"3. A double ash pit and means of wetting down and cleaning ash pans economically.

"4. Method of loading ashes into the ordinary steel car equipment by means of conveyors.

"5. Turntable not less than 85 ft. with (preferably) an electric motor as power for handling same.

"6. Door with at least 35 per cent. glass for lighting purposes; also locks at top and bottom and posts so that the doors may be locked open as well as locked shut.

"7. Smoke-jacks so arranged that engines may be moved a quarter of a turn, and equipped with suction ventilators so that the harder the wind the stronger the up-draft.

"8. A system of ventilators on top of the roundhouse for catching the steam and other waste products from a locomotive.

"9. Water pipes, air pipes, blow-off pipes, steam pipes and a good-sized steam supply pipe and taps for these for each pit.

"10. A permanent, sanitary, dry floor; not a gravel or cinder floor, but a concrete foundation with wooden blocks set on edge, filled in between with tar and cement, and so fitted in as to drain any water into the pits.

"11. A tool room for the care of all general roundhouse tools.

"12. A wash room for engine crews, lockers for their extra clothing, etc.

"13. A centrally located office, and telephone facilities for the foreman.

"14. The low, flat roof of roundhouses is to be discouraged on account of the drippings in cold weather, and the impossibility of properly ventilating same.

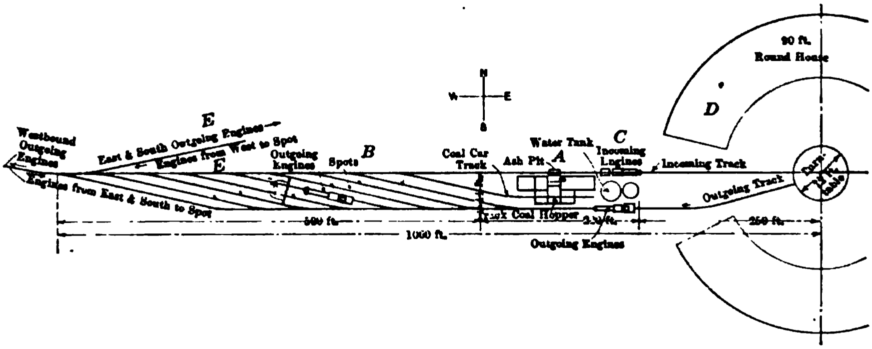

FIG. 179.—Master Mechanic's Association suggested engine-house lay-out.

The objections to plan in Fig. 179 of the Committee of the Master Mechanics' Association, as seen from an operating view-point, are:

(a) Too many switches to look after and too much switch cleaning for the engineering department to attend to at times, when, owing to snow storms and extreme low temperature, the limited number of men usually available for such purposes are kept busy keeping yard tracks open for operation.

(b) A switchman would necessarily have to be provided to attend "spot" switches.

(c) Conveyors for loading ashes are rather expensive, often out of order when most needed, and, as a rule, are unnecessary. The depressed track for ash loading is free from breakdowns and always in shape to use. Modern steel cars are not suitable for ash work, inasmuch as the bottom dumps provide a poor means of distributing ashes along the right of way for ballast, for which purpose, in most cases, they are used.

(d) The coal elevator and sand house should not be as closely adjacent as this plan provides, because of congestion likely to arise in handling and inability to expand, if necessary.

(e) The cinder, or ash pit, should be located on the house track as near to the door as possible, in order to curtail, to the minimum, the handling of engines without fire. It is often necessary to have fires drawn before an engine is put in house to enable repairs to be made in and about fire-box.

(f) Incoming tracks and outgoing tracks should be as distinctly separate as possible, otherwise delays will be common to outgoing engines unless the tracks shown at EE and FF are double, in which event more switch throwing would be necessary—an operation that should be eliminated as far as practicable.

With the exception of the above features, the general idea shown in the committee's plan is good and would certainly provide a means of handling power very promptly.

A committee of the American Engineering Association, made the following recommendations in connection with the design and equipment of engine-houses:

(1) In a circular house the locomotives should stand in the house normally with the tender toward the turntable.

(2) The distance from the center of the turntable to the inner side of roundhouse shall be determined by the number of stalls required in the full circle.

The length of the stall along center line of track should be not less than 85 ft. in clear.

(3) The clear opening of entrance doors should be not less than 12 ft. in width and 17 ft. in height. The angle between the adjacent tracks should be an even factor of 180 degrees, so that the tracks at the opposite ends of the turntable will "line up" with it.

(4) The turntable should be not less than 75 ft. in length. The table should be operated by power, preferably electric.

(5) The material used in construction of the house should be non-corrosive, unless proper care be taken to prevent corrosion.

(6) Engine pits should be not less than 60 ft. in length, with convex floor, and with drainage toward the turntable. The walls and floors may be of concrete and proper provision should be made in construction, for the support of the jacking timbers.

(7) Roundhouse doors should be made of non-corrosive material.

(8) Smoke-jacks should be fixed, have large hoods, constructed (preferably) of non-corrosive material, and supplied with dampers. The cross-section of the stack should be not less than 30 in. in diameter.

(9) The floor should be of permanent construction. It should be crowned between pits, and that part adjacent to pits within jacking limits should be of wood.

(10) Drop pits should be furnished for handling truck wheels, driving wheels and tender wheels. These can be most economically constructed in pairs.

(11) If the building is heated with hot air, it should be by the indirect method and the supply should be taken from the exterior of the building. (No re-circulation of air should be allowed.) The air should be delivered to the pits under the engine portion of the locomotive. Air ducts should be located under the floor and special precaution should be taken to keep them dry.

(12) As much light should be obtained from the exterior of the building as good construction will allow.

(13) There should be an arc light and a plug outlet for incandescent lights, in each space between stalls.

(14) The contents of boilers should be taken care of and discharged outside of the building in a suitable receptacle, and the heat units used as might be deemed best.

(15) Cold water should be supplied at each alternate space between stalls, from an outlet not less than 2.5 in., located at a point about opposite front end of fire-box. The water pressure should be not less than 80 lb. The hydrant should be located below the floor in properly constructed pits amply drained. Modern practice requires the use of hot water in the maintenance of boilers.

(16) Compressed air is used for mechanical hoisting and blowing operations. Overhead outlets should be furnished in each space between stalls opposite front end of fire-box. The pressure should be from 80 to 100 lb.

(17) A roundhouse should have facilities for the location of a few necessary machine tools, preferably electrically driven.

(18) Air hoists, or portable goose-neck cranes with differential blocks, on wheels, should be furnished for handling heavy repair parts.

(19) The turntable pit side walls should be of concrete with wooden coping not less than 6 in. thick, and the ties under the circular rail should be supported on concrete walls. Pivot masonry may be of concrete with stone cap.

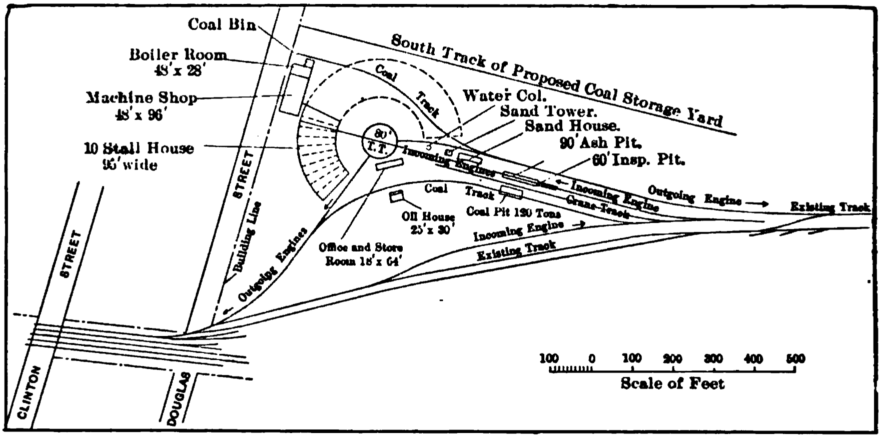

Fig. 180.—Engine-house and facilities, Collinwood, Ohio—Lake Shore.

Most houses are of wooden roof construction with the walls of brick, stone or concrete. The last is used in the form of blocks or solid construction. The depths of stall is seldom less than 80 ft. and many even exceed this figure. Pits are from 50 to 60 ft. long, with the bottom sloping in either direction as best suits the layout of the drainage system. The center of the pit floor is crowned so the workman can have as dry a place as possible to stand on when under the engine. The depth of the pits varies considerably, but a fair average is 2 ft. 6 in. at the shallow end and 3 ft. at the deep end. Some form of hot-blast system of heating is now almost universally adopted. On account of its assisting materially in the ventilation of the building, it has met with great favor.

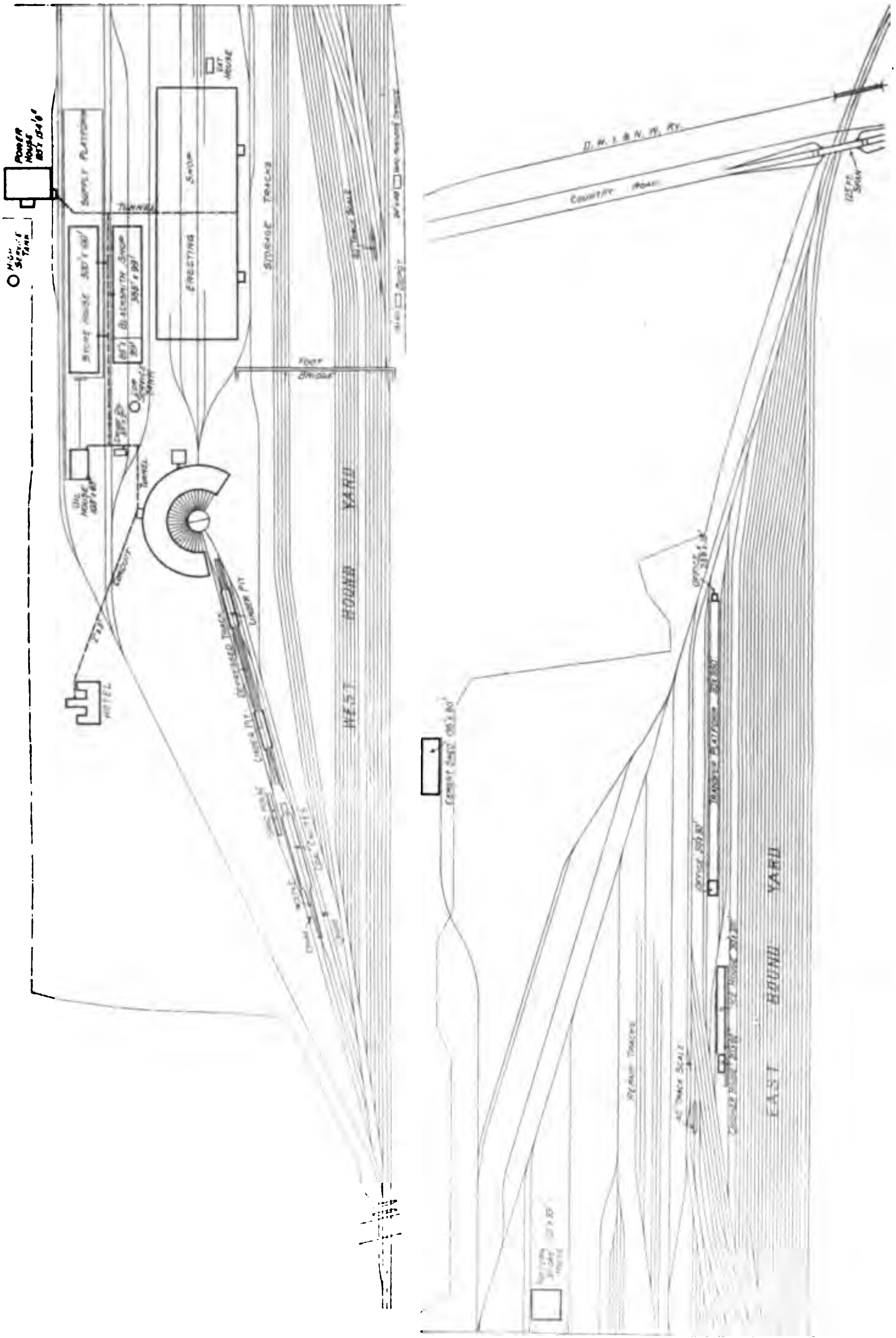

FIG. 181.—Shop, yard and engine-house, East Moline, Illinois—Chicago, Rock Island & Pacific.

At the Collinwood, O., engine-house of the Lake Shore, Fig. 180, there is a duplicate arrangement of tracks and ash pits for the outside work, which permits of taking coal, sand and water from either side of the chute. There are two outgoing tracks with short pits on each. On each ingoing track there is an ash pit capable of holding two engines. Over each pair of ash pits there is a pneumatic hoist, each taking care of the ashes from a long and a short pit. A clam-shell bucket is used to receive the ashes from the engine. Next is a 4-in. washout line with 2.5-in. connections between alternate pits. Near the inner circle is a 1.25-in. air pipe with .5-in. outlets between alternate stalls.

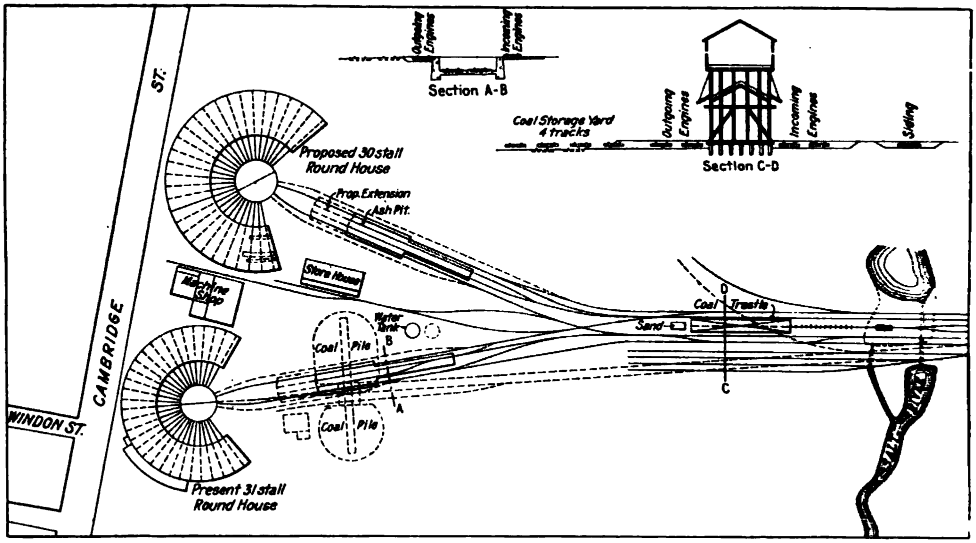

FIG. 182.—Engine-house lay-out, Beacon Park, Boston—Boston & Albany.

The wasteful effect of poor designs may be observed at almost any engine terminal: where men are shoveling ashes from a pit to the ground and then rehandling to cars; where a turntable is just about the length of the wheel base of the engines it turns and where engine-houses have to care for engines so large that doors cannot be closed behind them.

Figure 181 is a plan of the complete shop, yard and engine-house layout of the Rock Island at East Moline, Ill. The plan gives an impression of roominess and easy movement into and out of the engine-house and the various facilities.

The plan in Fig. 182 is that of an exceedingly interesting development of engine terminals of the Boston & Albany at Beacon Park, Boston, showing an engine-house of the circular type with 31 stalls, and another in process of construction, with 30 stalls, with the attendant facilities.

Figure 183 is another unique development of Boston & Albany engine terminals, at West Springfield, Mass. One existing house with 44 stalls is shown and another house, with two turntables, is planned, with a total additional capacity of 70 stalls, of which 21 are to be constructed immediately. This plan is instructive too in the study of the track layout and location of coaling plants, sand plants, ash tracks, repair shops, offices, etc.

The engine-house in East Altoona, Pa., shown in plan and elevation, Fig. 184, is probably the largest engine terminal on the Pennsylvania system and handles more engines than any similar plant in the country.

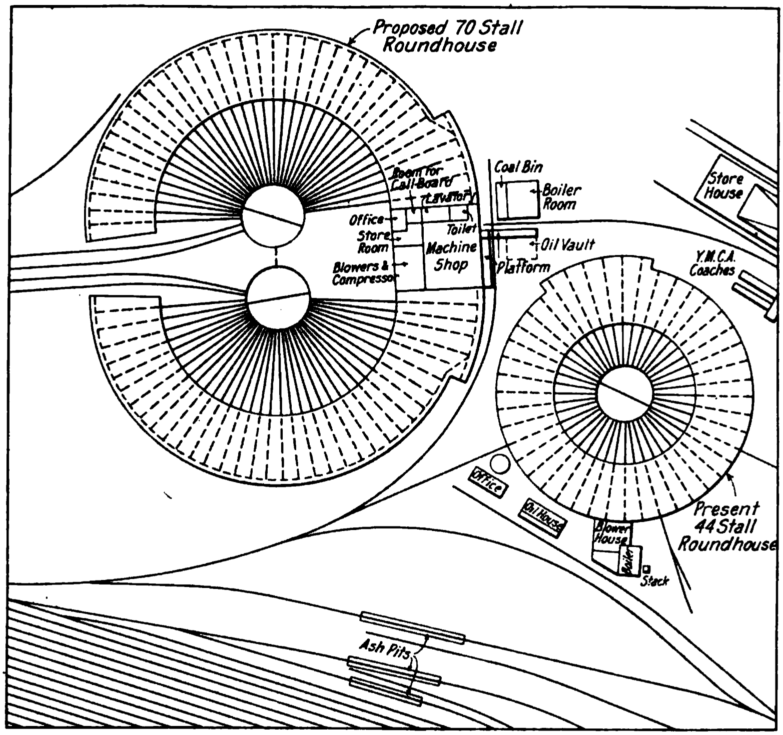

FIG. 183.—Engine terminals, West Springfield, Mass.—Boston & Albany.

The section through the roundhouse and the side elevation of the coal chute are shown in the upper part of the drawing. Outside of the engine-house, there are two storage yards, having a capacity to care for 75 locomotives each, and so arranged as to reduce handling to a minimum. A fuller description of this plant, with special reference to the ash and sand handling features, is given under Chapter XXIX on that subject.

At Decatur, Ill., the Wabash has a good 42-stall engine-house, which is similar to other recent standard layouts for handling of many engines

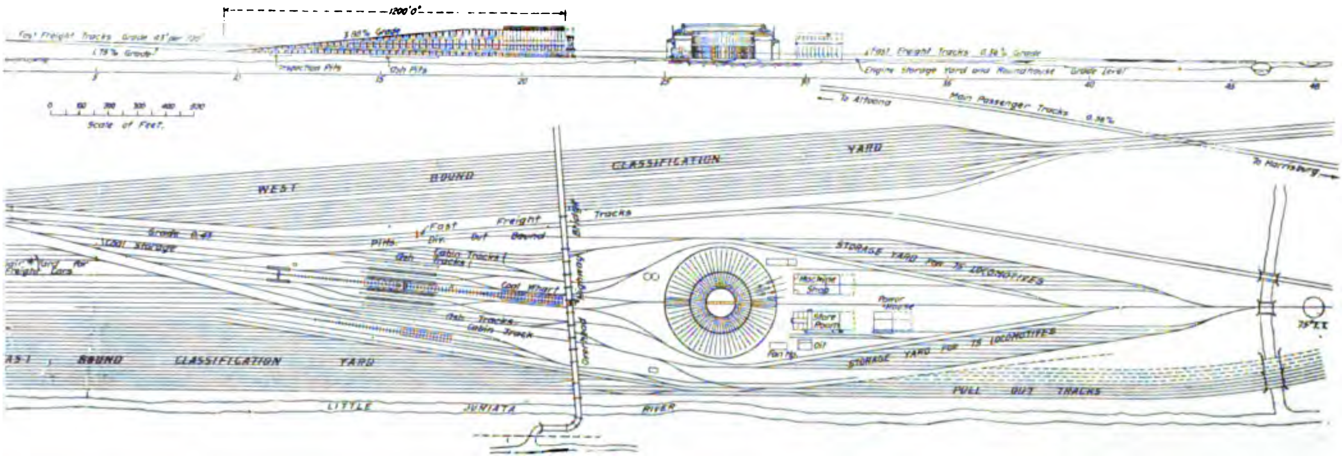

FIG. 184.—Plan and profile of East Altoona freight yards and engine terminal—Pennsylvania Railroad.

of heavy design. The detailed drawings, shown in Figs. 185 and 186 are of the elevation of end walls and the cross-sections through engine-houses are interesting.

One of the latest words in engine-house design and construction is that of the New York, New Haven and Hartford, at New Haven, Conn., of which a general plan is shown in Fig. 187. This layout was put in operation Sept. 1, 1912. It consists, as indicated on the plan, of a 43-stall house, with provision for a second house, of the same capacity when needed. The construction is substantially all of metal, concrete and stone, and, therefore, practically fireproof. Hot-air heat and incandescent electric lighting are provided. The turntable is of standard length—75 ft. The machine shop is 75 ft. by 160 ft. There are three drop pits in the house. A covered passageway connects the house with machine shop. Toilet-rooms, wash-rooms, locker-rooms and other conveniences are arranged for. The arrangement for avoiding interference between incoming and outgoing engines and the passing of assigned or preferred engines around others is apparent and a very necessary pro-

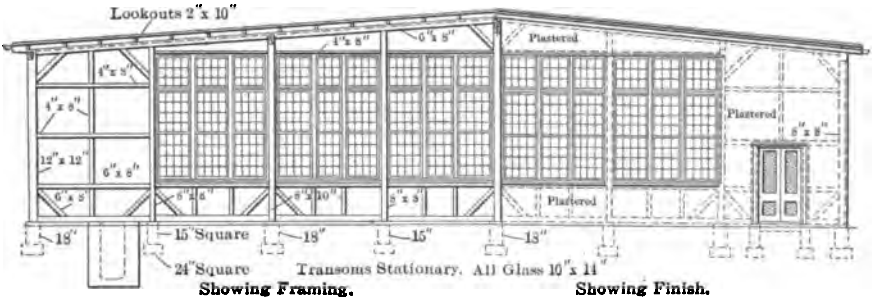

FIG. 185.—Elevation of end walls, Decatur, Ill., engine-house—Wabash.

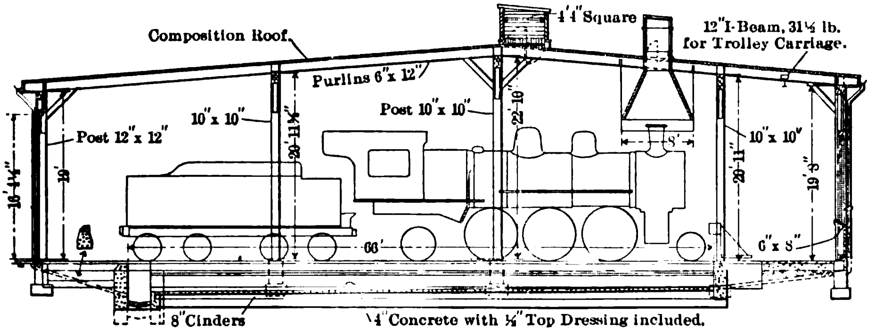

FIG. 186.—Cross-section, through Decatur, Ill., engine-house—Wabash.

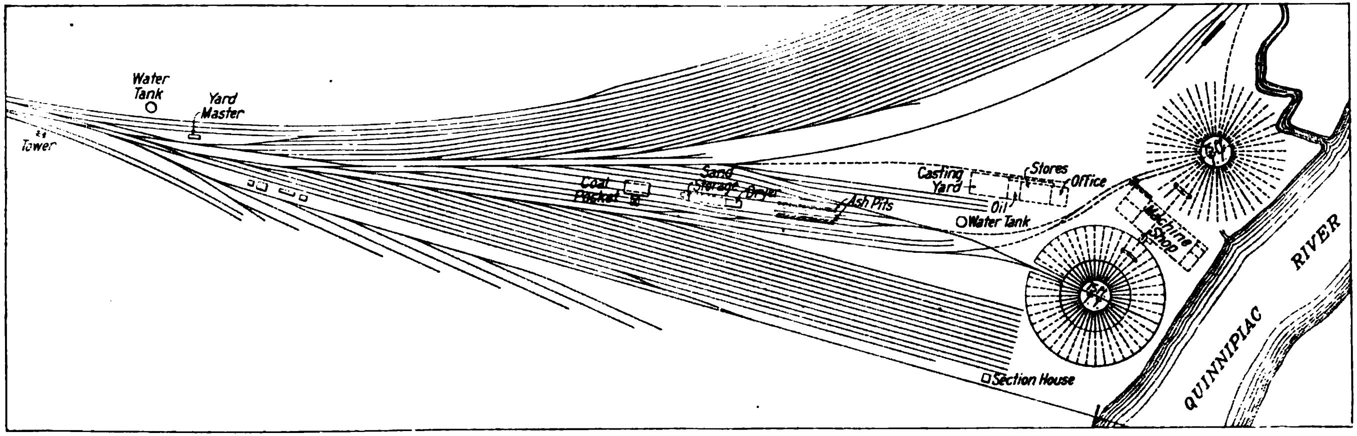

FIG. 187.—General plan of engine terminals, New Haven, Conn.—New Haven Road.

vision on a road like the New Haven where there are many classes of freight and passenger service to be handled.

An engine-house, with its accompanying facilities, erected at Carbondale, Pa., by the Delaware & Hudson, and put in operation during the summer of 1912, is shown in plan, Fig. 188, and is unique and interesting largely because of its dimensions. Unlike the New Haven, where the large freight engine and the heavy freight train-unit are, as a rule, not only impracticable but uneconomical, the Delaware & Hudson, by reason of its heavy grades and preponderance of coal traffic, finds it economical to utilize engines of the Mallet type, and the engine-house at Carbondale was especially desired to meet this condition. The features are heavy fireproof construction, 41 stalls, a turntable 90 ft. long, with three tracks approaching it from the outside; diameter of inner circle 199 ft. 8.75 in., outer diameter 407 ft. 11.75 in., giving a stall length of 104 ft. 1.5 in. Each stall has approximately 400 sq. ft. of window area in the outer wall. The view across the turntable, Fig. 189, conveys a good impression of the liberal dimensions and substantial construction.

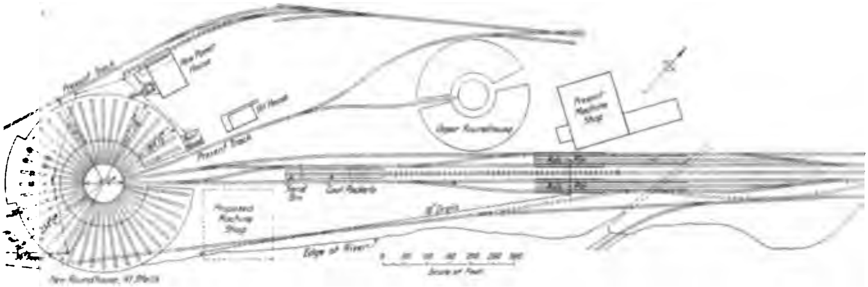

FIG. 188.—General plan, Carbondale, Pa., engine terminals—Delaware & Hudson.

Hot water for washing out boilers saves time, labor and material. Large engines have been turned and heated at engine-houses—including washing of boilers with the hot water system—in 4 hours and 45 minutes. At houses where a large number of engines are handled, a hot water system is desirable. It saves time (a very important consideration) and also materially reduces leaky flue troubles; further, it has the advantage of avoiding filling the house with steam during the period of blowing off.

Where hot water washout system is not installed, it is necessary to have a pressure pump to furnish a pressure of somewhere near 90 lb. per square inch to wash out boilers. The capacity of the pump depends on the number of engines washed out at one time, which in turn depends on the number of engines on a division and the quality of water.

It is common practice to run a line of water-pipe around the house and make hose connections at posts, from which tender tanks of locomotives are often filled by connecting up to this line.

In addition to water and compressed air piping systems, engine-houses are usually piped for steam under a pressure of 110 lb. per square inch, to be used for blowers. The piping is run overhead on walls or posts, and hose connections are provided in convenient places, thus eliminating all underground piping, except for drainage purposes.

Heating and ventilating engine-houses is being given more attention. The hot-air system is successful. A fan forces hot air through underground ducts into the pits. As the hot air is delivered at the points desired, it is probably more efficient than steam. Engines coming in coated with snow and ice are quickly thawed out. In ordinary winter weather the fan is usually run at a speed sufficient to change the air every 14 or 15 minutes, but in very cold weather it would probably be necessary to change the air every 6 or 7 minutes. The principal objection to the steam piping system is its dependence to a great extent on natural draught, which cannot always be relied on, while with the hot air system, the large volume of warm air which is continually forced into the house, drives out smoke and gases through ventilators on the roof. The necessary amount of warm air varies with the temperature, the pressure of steam in heating coils, etc., but good results are obtained with about 1800 cu. ft. per minute, per pit.

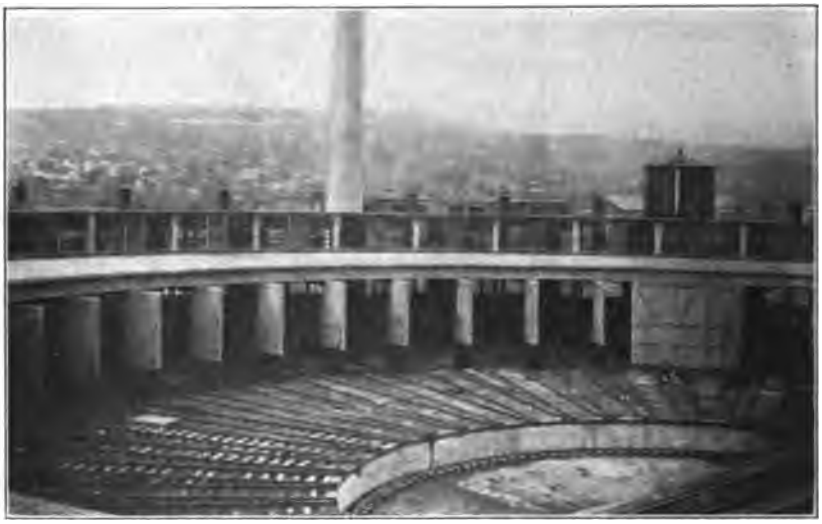

FIG. 189.—Inside circle view of Carbondale engine-house.

The conclusions of the Master Mechanics' Association were that heat should be concentrated at the pits for the primary purpose of thawing out engines; that there is no need to have the house very warm, as the men are warmly dressed and will work faster if not too warm. Good results are obtained by the use of steam heat coils in the pits; positive circulation being required, the vacuum return system seems best. In using steam coils care must be taken to prevent water from splashing on the pipes, as it forms a fog in the house and tends to crack the pipes, causing leaks. While steam is cheaper than hot air, the maintenance cost is larger. General temperature should be maintained at between 50 and 60°.

Smoke removal should be separately provided for by the use of jacks, and the currents produced in the jacks should be utilized for aiding ventilation in the house by drawing air from the top of the house through annular openings leading into the top of the jack. Jacks should be without dampers, fixed, and built of non-corrosive material with cross-section not less than 30 in. in diameter. They should be of smooth material, circular in section above the hood, and extending well above the roof line. In design, care should be taken to avoid any corners. The hood of a jack should have a minimum length of 10 ft. so as to permit variation of location of an engine on the pit. The bottom of the jack should be as low as the engines served will allow and it should be furnished with a dry trough. The slope upward should be gradual to the flue.

A smoke-stack—or smoke "jack"—must be arranged for each engine stall. Many difficulties have been encountered in endeavoring to secure jacks which will not give out in a short time. Sheet iron is eaten out quickly by gases; cast iron is better but very heavy and awkward to handle; galvanized iron lasts longer and is lighter than either. Smoke jacks of thin, rolled plate have a very short life and are not worth installing. Wood lasts longer than might be expected and, in connection with a fireproof roof, should prove economical and safe. It is not necessary to sand the interior of the jack, though the exterior should be well painted. Tile is more expensive, and its weight and liability to break, if detachable, are objectionable features. Asbestos is light in weight and is fireproof, but is more expensive in first cost. A telescoping jack, provided with a bell having a diameter of about 4 ft., is satisfactory. A jack is being made of an asbestos fibrous material which is also used for fireproof roofing. Asbestos or asbestos fiber is probably the most desirable and should be used if the appropriation will permit.

The lighting of engine-houses is an important problem; and to secure proper illumination electricity is frequently used. A common method of lighting is to place incandescent lamps on posts between pits. Preferably these should be placed about 10 ft. from the floor to prevent their being removed. Another manner of lighting is to place one arc lamp between each pit. Placing the wires in iron conduits is poor practice, as gases corrode the conduits rapidly. The open wiring system is used more extensively and is satisfactory. The wires are run on porcelain knobs along roofs or walls, the incandescent lamps being suspended from ceiling or fastened to walls. The outlets should be located between pits, for plugging in portable lamps to be used by men working on engines.

The turntable, coal chutes, coal pocket, sand spouts, water columns, ash pits, etc., as well as tracks and yard, should be properly lighted; and where a large quantity of electricity is used, it will be found cheaper to install a generating set than to buy current.

The inspection pit is an adjunct to engine terminal facilities, of much importance and should be located so that engines moving toward the engine-house will first pass over it. It should be deep enough to permit men to walk under the engine and examine all its parts. Engines should be stopped on it on their arrival and thoroughly examined by inspectors. Oftentimes an engine reaching this pit will be found, on inspection, to have but a few nuts loose here and there, or to need only some slight repairs that can be made on the pit. The engine then passes along through its different operations, goes on the table to be turned, and is ready for a return trip.

Turntables are of various designs, but are almost invariably too short and of insufficient rigidity, causing them to turn very hard. In northern climates the paving of the turntable pit and the bench wall for the circular rail should be kept some distance below the bottom of the table, to avoid interference from light snows.

Where 100 to 150 or more engines a day are handled, the cost of handling will range from $1.10 to $2 an engine and includes inspection, cleaning fires, starting fires, wiping, watching, washing boilers and supplying coal, water and sand. The cost during severe winter weather or where boilers are washed out more than once in two weeks, often exceeds these figures.

The cost of turning an engine on the turntable depends upon the power used to move the table. With hand power the cost is from 4 to 8 cents per engine. Where more than 75 engines are turned in a day it is economical to install power-driven tables. If power is available it may be economical to use power-driven tables where only 35 or 40 engines are turned in a day. The cost of turning 250 engines a day is:

With electric motor without special dynamo..........	$3.92
With steam engine....................................	4.40
With gasoline motor..................................	3.95

This covers the cost of labor, fuel or current, supplies and repairs. The records of one road give the cost of turning engines by power at different points as follows:

	H. p.	Engines per day	Average cost: per day	per engine
Gasoline motor.........	5	170	$3.78	2.22 cents
Gasoline motor.........	5	110	3.42	3.09 ..
Gasoline motor.........	5	194	3.55	1.83 ..
Gasoline motor.........	5	121	3.41	2.90 ..
Gasoline motor.........	5	45	2.91	6.50 ..
Electric motor..........	20	140	3.99	2.85 ..

The cost of installing an electric motor, a gasoline engine and a steam engine, is about $1400, $1000 and $1200, respectively.

Many master mechanics favor two motors on turntables at heavy terminals—a gasoline motor at one end and an electric motor at the other—to be prepared for the emergency when one of them becomes disabled. It is well known from experience that these troubles almost invariably occur during hours of heaviest movement or during the late night hours, and in cases of snow or storm, when it is difficult to obtain quickly sufficient manual labor to turn the tables. It is a fact, too, that a table once turned by a motor is not readily moved by hand, as its adjustment is not usually taken care of as it would be if it were being turned by hand; and the weight of the motor and gearing increases the weight of the table and its resistance to movement.

Terminal handling costs vary greatly. Methods of handling and of keeping records differ greatly. One road "handled" over 42,000 engines at its terminals at an average cost of $1.52, divided up: ash pit, .18; cinder pit, .10; inspection .09; cleaning tubes and grates, .05; wiping, .48; preparing, .26; supplies, oil, waste, etc., .07; callers, .06; turntable men, .07; other expenses, .11; hostlers, .05. When boilers had to be washed that was figured at $1.41 additional.

Another road places these handling costs at from $1.20 as a minimum to $1.56 as a maximum.

The different items have been summarized as follows:

Hostlering..............................	50 cents per engine.
Turning..................................	5 cents per engine.
Cleaning fires..........................	15 cents per engine.
Wiping...................................	50 cents per engine.
Inspecting..............................	15 cents per engine.
Firing up................................	10 cents per engine.
Calling..................................	5 cents per engine.
Total..........................	$1.50

Performance sheets of several prominent roads show an average of 1.3 cents a mile. The average monthly mileage may be 3600, or 120 miles daily. Assuming each engine would reach a terminal once a day, the cost would be $1.56, closely approximating the $1.50 in the foregoing detailed statement.

Firing up is done in many ways. The old method of firing up necessitated the use of wood. If wood costs $2. 50 a cord, and estimating one-eighth of a cord used, the cost would be 30 cents for each engine fire started.

Fuel oil costs about 3 cents a fire. The oil is used to ignite the coal. It is often advantageous to have wood ashes on the grate, as with some coals the oil blast has a tendency to fuse them and form clinkers on the grate bars. The amount of coal used in addition to the wood or oil has been given as low as 500 lb. and as high as 1500 lb., depending upon the size of engine.

After the fire has been lighted the engine must be watched until taken from the house and the attendant must see that the water level is maintained and that the boiler is not allowed to blow off. Incompetent help has frequently ruined boilers in firing up without water. One fire builder can start 20 fires during his watch and giving about half an hour's attention to each locomotive. The labor would therefore probably amount to 10 cents for each fire started.

Calling is usually done by boys earning from $15 to $20 a month. Fifteen minutes to a call may be deemed a fair average—or 30 minutes for the two men needed, say 30 minutes per engine. This work will therefore average 3 or 4 cents for each locomotive started. Between calls the boys may be used on other work.

Machine tools are supplied for an engine-house, particularly where the location is not in close proximity to the main shop. Where the engine-house is entirely self-supporting, a proper outfit should be supplied to take care of anything that may come along.

In addition to the small tools owned and carried by the various mechanics, the Master Mechanics' Association Committee recommends the following:

1 48×28-in. by 8-ft. planer.
1 24-in. lathe.
1 40-in. heavy drill press.
1 20-in. drill press.
1 emery wheel.
1 16-in. bolt lathe
1 22-in. shaper.
1 bolt-cutter to take up to 2-in.
1 36-in. boring mill.
1 hydraulic or screw press for driving box brasses, rod bushings, etc.

Suitable cranes around engines and drop pits, either supported by posts or roof, so as to take care of air pumps, steam chests, front end doors, driving boxes and other heavy parts. The lifting on and off of cabs is something that should not be overlooked.

A driving-wheel drop pit capable of taking care of at least two engines at a time.

1 engine truck drop pit capable of taking care of at least 2 engines at a time.
1 tender truck drop pit, if trucks are suitable for wheels to be dropped.
2 gasoline or oil tire heaters, with proper-sized hoops and burners; can be used for straightening frames, etc.

1 rotary valve-seat planer of sufficient size to take the largest-sized seats.
1 boring bar for piston-valve bushings.
1 cylinder boring bar.
4 piston-rod pullers, various sizes.
12 differential chain hoists.
4 1/2-in. grab chains.
4 5/8-in. grab chains.
12 pinch bars.
12 heavy capacity jacks, 35 or 40-ton, hydraulic or lever.
12 screw jacks for holding up work.
4 lever journal jacks.
2 lever jacks for pilot and tank work.
2 air hammers made out of pipe or old hydraulic jacks for driving out rod and frame bolts.
6 air motors, various sizes, two to be end motors for close work.
4 crosshead lifters.
2 spring pullers.
3 close chisel bars.
6 long chisel bars.
4 two-wheel trucks for moving material.
1 blacksmith forge.
1 set ratchets and rollers for valve-setting.
2 4-wheel rod trucks.
1 portable arrangement for hydrostatic test.
1 steam-gage tester.
1 complete set of twist drills, 1/4-in. to 2-in.
1 small breast drill.
1 complete set standard reamers, 3/4-in. to 2-in.
1 pipe vise.
1 complete set of standard taps, 1/4-in. to 2-in.
Cold chisels, as many as necessary.
1 complete set of pipe cutters, dies, and taps, from 1/4-in. to 3-in.; sufficient adjustable pipe wrenches to accommodate the force of men that the work requires.
6 each, open wrenches, 3/8×5/8-in. to 1 1/4×1 1/4 inches.
2 each, large-size open wrenches, up to largest size nut on locomotives.
6 mauls, various weights, 8 to 16 lbs.
12 handle punches, 3/4 to 1 1/4-in.
2 pneumatic hammers for boiler-makers, chipping, etc., caulking tools, etc.
1 complete set stay-bolt reamers and taps; in fact, complete outfit for stay-bolt, flue and grate work.

Sufficient chisels, gages, hack saws, files, scrapers, straight-edges, etc., to accommodate the force maintained at each roundhouse in order that one man may not be held up on a job waiting for another man to get through with some small tool.

In addition to above it is suggested that there should also be provided:

A long master wedge for drawing piston rods into cross-heads before the regular wedge is applied.

A small bolt lathe, mounted on a truck and run by electric or air motor, for use around an engine where new rod, truck or cylinder bolts are being fitted, to save running back and forth to machine shop.

Each engine-house should have a separate tool-room of its own, with a man in charge, both day and night, to handle the tools on a check system; otherwise it will be impossible to maintain engine-house tools.

The use of a floating or hospital gang in engine-house is suggested, to which gang will be turned over the heavier jobs so as to get engines into service quickly, instead of having the work drag along with various men being put on and taken off according to the exigencies of the service.

This system will often enable an engine to be kept out of back shop and will increase the mileage between shoppings.

One engine should always be kept on blocks undergoing moderately heavy repairs so that machinists can be kept busy at all times when work in the roundhouse falls off temporarily. It is claimed that work done in this manner costs more, but where business fluctuates it is a good proposition.

The neglect of running repairs causes engine failures to increase and also decreases the life of an engine between shoppings.

Engine tools are those carried on each locomotive. These usually consist of a hammer, wrenches, chisels, oil cans, lanterns, signals, scoops, firing bars, torches, etc. One of the problems is to check up these tools and to induce the enginemen and fireman to properly care for them. The small tools should be kept locked up in metal boxes, preferably numbered to correspond with the number of the engine to which they belong. Where it can be done, the best plan is to have each engineman deliver his box to the tool room or other designated point, at the end of each trip, when the contents may be checked up. Where engines are regularly crewed, instead of being "pooled" it is not so difficult to keep up the equipment of small tools. The cost for tools and supplies will average about 20 cents for each trip. The cost for tools alone will, on larger roads, range from $10 to $40 yearly for each engine in service.

Wiping or cleaning is one of the most neglected duties at the engine terminal—and not the least important. On some roads the engines handling the most important passenger trains are permitted to go out of terminals looking as though they had been rolling themselves in a clay bank. The engines have been growing in size and as they increased, the fireman has been required to do less and less cleaning; now he is usually required to clean only above the running board. Where engines are "pooled," the crews naturally take less interest in keeping them clean; the roads hesitate to incur the expense of wipers, and the engines receive little attention. To wipe an engine properly and thoroughly will cost anywhere from 35 to 65 cents, depending on its size and condition and largely on how often it is wiped.

Organization of the help is more essential in obtaining good results than anything else and without it the facilities provided will be useless in securing quick handling and turning of engines. This subject is treated more fully in another chapter. A good engine-house foreman must, of a necessity, be a good organizer, and upon his ability in this line will depend his successful operation of the plant in his charge. The usual form of organization is to give the foreman complete control of all the terminal facilities for handling the engines, with the possible exception of the men at the coaling plant. These are sometimes handled by the operating department. At large plants, where the duties require it, the foreman has an assistant who handles the mechanics and distributes the work among them, seeing also that the work is properly done. It is also the usual practice to have a sub-foreman in charge of the engine-dispatchers, ash-pit men, wipers, etc. The foreman himself is thus relieved of much of the detail work, and can apply his labors to general duties, such as assignment of engines and crews, investigations of breakages, making reports to the master mechanic and superintendent, and keeping himself generally informed as to the requirements of the service.

CHAPTER XXVIII

ENGINE COALING PLANTS

Arrangements for supplying coal, water and sand to locomotives, and for cleaning their fires, removing ashes from ash pans and cinders from front ends, and enabling thorough and prompt inspection of machinery and boiler to be made, are essential; and such layouts, well located and suitably adjusted contribute much to the smooth and economical handling of traffic. Without good locomotive service a railroad is helpless; and without suitable and ample engine-house accessories, such service is extremely difficult.

The size of the appropriation to be made for a locomotive coaling-plant should be governed primarily by the number of engines coaled and, secondarily, by the kind of coal used, whether the mixing of coal is necessary or not, and the amount of coal to be supplied during "rush hours." Occasionally the management may decide that it cannot afford to put in all the appliances needed at a large coaling plant. This impression is often due to lack of knowledge as to conditions or lack of appreciation of the importance of such facilities; otherwise the fact that it cannot afford to do *without* them would be apparent.

As an illustration: A fairly well-equipped coaling station in a northern climate was without provision for thawing coal in pockets or in cars to be dumped, although ample boiler capacity for generating steam was close at hand. The division officers were unable, for several years, to obtain authority to spend about $500 to install the necessary steam-pipe lines. A force of five men during the day and the same number at night took care of the work during the summer and in mild winter weather. During about 3 months each year, 20 to 25 men were required in the daytime and 10 to 15 men at night, picking the coal loose in the cars and pockets. This was probably 20 or 25 men a day more than would have been needed had proper facilities been provided. About $2500 was wasted each winter because $500 was not spent to save it and a great part of the latter amount represented material in the estimates which had a permanent value. The actual loss was far greater since no account was taken of the waste of time to locomotives which could not be coaled promptly. There are many places where such conditions, with slight variations, exist.

Another instance: An outlying small terminal coaled from six to eight engines a day. The plant consisted of a board platform at about the height of a car floor. The intention was to shovel the coal from the coal car to the platform and then from the platform to the tender of the engine. This was done, ostensibly, to release the coal car. Ordinarily, however, the coal was received in cars of 80,000 lb. and 100,000 lb. capacity, which had sides so high that after a part of the top of the load was shoveled off, the coal had to be dumped on the track and then shoveled from the ground to the platform and again to the engine tender. The difficulties were increased by snow and rain, and by the coal freezing in cold weather. The force employed was not only greatly increased, but frequently the engines could not be coaled in time for their runs. Frequently they were run to other coaling stations some distance away where the men in charge already had troubles of their own. The division officers prepared plans for a coaling plant, taking advantage of high ground, at a cost not exceeding $4500, which would enable all the work to be done with two laborers a day and not exceeding three during the coldest weather, as steam piping was provided for. As the old method required at times from 5 to 10 laborers, it was estimated that with the proposed plant, a saving in wages of $2500 annually would be effected and a still more important saving in the time of engines and avoiding disarrangement of schedules. They failed to secure the appropriation.

A simple type of coaling station is that in which the coal is delivered on an elevated platform, loaded into barrows, carts or buggies, tracked to the edge of the platform and dumped directly into the tenders, the platform being about the level or slightly above the top of the tender. The ordinary barrow used for this purpose. is 9 ft. long, 30 in. wide and 30 in. deep, with a capacity of 38 cu. ft.

In constructing a coaling plant, ample provision for storage should be made, so as to meet the conditions of irregular or intermittent supply often caused by labor troubles, temporary suspension of mining operations, or road blockades. In northern climates it is desirable to store the bulk of the winter's supply before winter sets in, because weather conditions then render the movement of coal on rail and water lines unreliable; also because it avoids hauling company supplies during the season when roads are usually taxed to their utmost with revenue freight traffic. Storage plants should be roofed over to prevent the coal from being drenched and frozen solidly, making it difficult and costly to handle. Coal should be handled as little as possible not only so as to reduce cost of handling but also to avoid breakage. In delivering to engines it should be measured or weighed. As a general policy, a small number of plants of ample capacity and well located should be erected rather than a larger number of plants of less capacity and disadvantageously located. Coal should be taken only at division or run terminals.

The most primitive and expensive method of coaling, is shoveling from cars into tenders. If coal is not frozen this can be done at a cost of 15 to 35 cents per ton. The use of coaling cranes and buckets is increasing and in this manner the coal can be handled for 7 to 15 cents per ton; in some instances it has been claimed to cost less but it is possible that all items of expense were not included. Elevating coal to inclined approaches and dumping in platforms level with tops of tenders, costs 5 to 15 cents. The use of chutes above tenders, dumping by gravity, enables transfer to tenders at as low a cost as 4.5 cents per ton in some instances, and even lower costs have been attained. The patented systems—such as various types of conveyors—require considerable machinery and the use of some form of local power, but are reliable and efficacious and enable a low cost when large quantities are handled.

For trestles or pockets requiring elevation of coal in cars, inclines are constructed, usually 400 to 600 ft. in length, with a rise of 3.5 to 5.0 ft. in 100; although in some instances these grades have been made as high as 8 or even 10 per cent. On grades above, say 5 per cent., locomotives are not permitted to go on the incline, but use other cars to push with. By using cables and a "bunter" (sometimes termed a "Billy-goat"), cars may be pushed up much steeper grades—as high as 18 to 22 per cent. grade being used at times.

To cause bituminous coal to run freely out of pockets, starting it from a standstill, a slope of 45 degrees should be arranged; in many cases it is made 50 degrees so as not to have less than 45 degrees in the valleys of the coal pile. For anthracite coal the angle of repose is considerably less; 35 degrees is usually deemed sufficient.

The approximate cost of handling fuel coal, by various methods, has been given as follows:

		Per ton
1.	Shoveling from railroad cars to tenders	25 cents.
2.	Shoveling from cars to high platforms and again shoveled onto tenders	25 to 50 cents.
3.	Crane and bucket from storage platform	35 cents.
4.	Shoveling from cars into bins from elevated trestle	10 cents
5.	Dumping from railroad car directly into bins and by gravity into tenders	1.5 to 3 cents.
6.	Hauling railroad cars by cable up steep incline and dumping directly into bins	3 cents.
7.	Dumping from railroad cars into pit and elevating by conveyors	3 cents.
8.	The same as above, but elevating by air hoist	5 to 10 cents.
9.	Locomotive crane working from stock pile to bins or to tenders	1.75 cents.
10.	Dumping through trestle to platform and tramming and dumping into tenders	10 to 15 cents.
11.	Dumping into pit in track and elevating skip by switch rope by engine taking coal	5 to 10 cents.

It may readily be determined from the foregoing whether sufficient coal is handled at any one coaling station to enable the direct saving in cost of handling to earn 10 per cent. on the cost of a modern coaling plant; allowing 5 per cent. for the interest on the money invested and 5 per cent. for depreciation of plant. The company's profit would have to be found outside of this and would be made up, aside from the actual saving over and above 10 per cent. of the cost of the plant, in several ways, viz., (a) quicker handling of locomotives, thereby to an extent reducing the number needed to move the traffic; (b) reliability and promptness, with which the service is handled; (c) less deterioration in the value of coal; and (d) prompt release of cars. The actual loss of fuel itself in repeated handlings by breaking it up is an item also to be taken into account. The loss results through deterioration in breaking up and disappearance of coal through wind gusts or being carried through flues and stacks of locomotives unconsumed.

Frequently roads store coal to guard against interruption to traffic due to strikes and other causes. Usually it is dumped on the ground and reloaded; occasionally the reloading is done with steam shovels. Coal exposed to the weather and stored upon the open ground is unfavorably affected and the heating value depreciates quickly. Bituminous coal, stored in heaps exceeding 12 or 15 ft. in height, frequently ignites inside and near the bottom, through chemical action and high pressure; and even though the fire may be extinguished, with much difficulty, by smothering, throwing heaps apart or forcing in steam through pointed, perforated pipes, the loss is often heavy. In loading, and especially with steam shovels, a quantity of stones and natural soil is likely to be picked up. The depreciation of any kind of coal, and particularly bituminous, stored in the open is so heavy, and danger from self ignition so great, that the government navy department experimented at Key West, Florida, during 1906, with coal submerged under salt water in concrete tanks. The submerged storage of coal will hermetically seal the gases in it. Small pockets of combustion cannot be formed while it is under water. Fires in coal stored under water are impossible. Coal so stored is delivered damp and there is no loss of coal dust carried by the wind. Coal storage methods are more fully discussed in Chapter XVII.

The kind and size of a coaling plant depends largely upon the kind of coal used. With straight bituminous coal the plant may be simple, as provision need only be made for storing one kind of coal and dumping it directly in the condition that it is delivered into the tenders of engines. In some instances coal is picked for engines on heavy or fast passenger runs. This only involves setting aside one or more pockets or bins for the purpose, unless the conveyor system is employed. On roads burning anthracite coal the problem is more complicated. Such roads seldom use anthracite exclusively, nearly all mix more or less bituminous coal with it. They are compelled to use anthracite "lump" on important fast-passenger engines; anthracite "broken" or "egg" on others; and a mixture of bituminous and small size anthracite on freight. Sometimes this is mixed in two or three different proportions for as many types of engines or kinds of service. Others use straight small-size anthracite, while some may burn straight bituminous. It will be seen that this complicates the coaling and it requires a well-arranged and rather extensive plant to do the work. While it has been attempted to furnish coal mixed in different proportions at "buggy" and "pocket-dump" coaling plants, the mixtures cannot be made with regularity and in uniformly maintained proportions. They will vary considerably and as the number of engines to be coaled increases, the variation in the proportions will become greater. Where this mixing is not thorough and uniform, the efficiency of the engine's steaming qualities is impaired. This usually happens when the greatest number of engines has to be coaled, *i.e.*, when traffic is heaviest and consequently at a time when engines are required to render their most efficient service. The difficulties encountered in heavy passenger or freight service are well understood, when the fireman runs into a pocket of the inferior coal on his tender while ascending a heavy grade or when approaching some other point where the engine's utmost capacity is required. A conveyor plant, arranged so that the coal can be fed to the conveyor and the feed adjusted for each kind of coal, will give a thorough mixture in practically the proportions desired. With this system ample storage capacity for each kind of coal is necessary.

The belt conveyor system is expensive, but for plants where coal must be mixed it is probably the best. Where mixing is unnecessary the most economical results have been obtained in the ordinary gravity-dump pockets where the loaded cars are pushed up an incline over the bins, dumped, and from these bins run into the tenders by gravity. The writer has handled coal at one of these plants, mixing it in various ways at a cost of a fraction over 3 cents a ton, while a conveyor plant may not load coal on the tenders for less than 5 cents and, more often doubtless 8 cents to 10 cents unless the amount handled is very large. The conveyor system, however, is the only one making a proper mixing possible.

A typical conveyor plant is that of the Lehigh Valley at South Plainfield, N. J., shown in Fig. 190.

Another similar plant which has been in service for many years is at Jersey City, on the Erie Railroad. It was designed to handle either lump anthracite, "run-of-mine" bituminous or bird's-eye and rice sizes of anthracite using as a binder a small proportion of bituminous. Fig. 191 shows a cross-section and Fig. 192 a skeleton elevation with the general arrangement of conveyors. The carrier is made up of a line of continuous overlapping buckets rigidly secured to two strands of chain, by which the coal is carried along the horizontal run and up the vertical leg without spilling. Above the horizontal run and at the left of Fig. 192 where a coal car is shown are two track hoppers into which the coal to be stored is dumped from the cars. Each of these hoppers is fitted with an automatic feeding chute, shown in Fig. 193. These chutes have a pair of

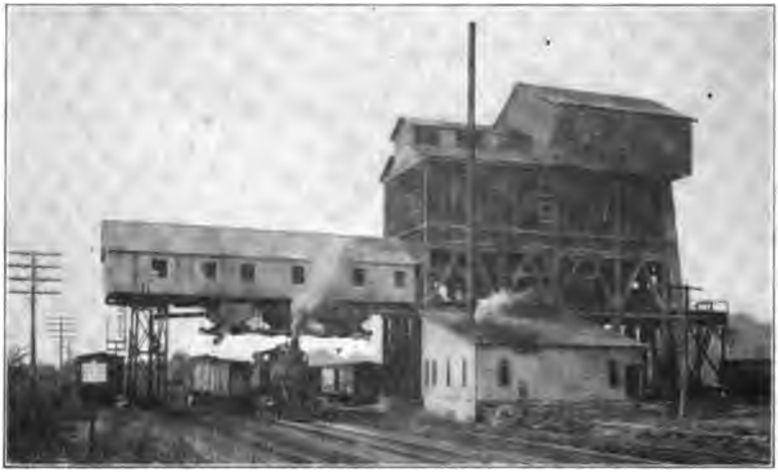

Fig. 190.—Coaling station, Plainfield, N. J.—Lehigh Valley.

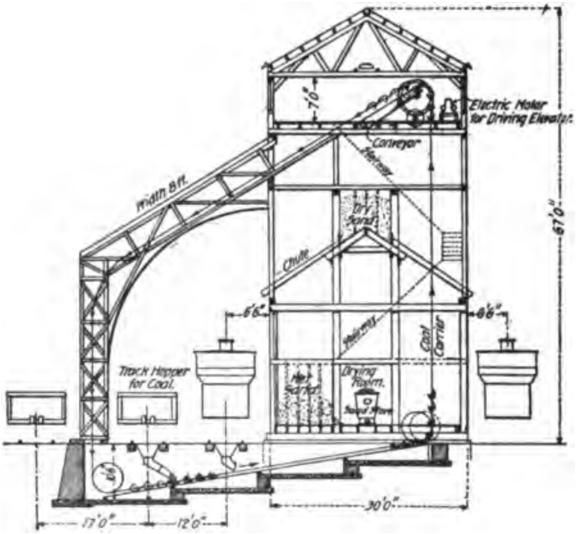

Fig. 191.—Cross-section of Coaling plant, Jersey City—Erie Railroad.

small wheels which travel on the top edges of the overlapping buckets. As the buckets move forward under the chute the wheels follow the serrated edges and the lip of the chute is alternately raised and lowered.

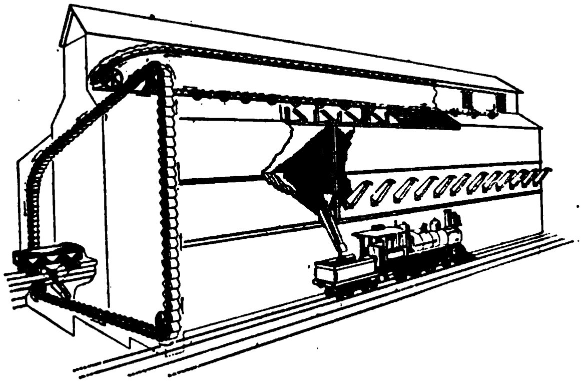

FIG. 192.—Skeleton elevation, showing conveyors, Jersey City—Erie Railroad.

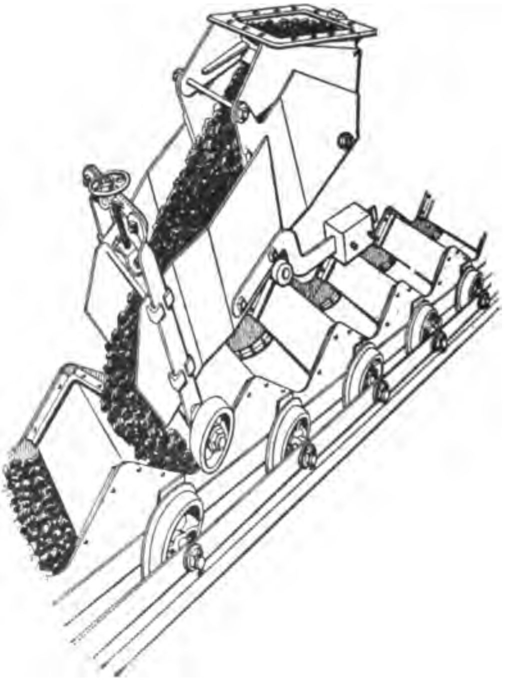

FIG. 193.—Mixing spout, coaling plant, Jersey City—Erie Railroad.

The amount of this movement is regulated by a hand wheel and determines the amount of coal delivered to each bucket. The loaded buckets on reaching the head wheels of the conveyor are inverted and discharge their contents into a chute leading to the horizontal conveyor running along the top of the storage pockets which have a capacity of 2500 tons. This is a double-strand, suspended flight conveyor, and by it the coal is deposited in any one of the 14 bins through gates in the floor of the trough which are opened and closed by hand wheels. The elevator and conveyor are driven with rope drives from a 36-h. p. gas engine, located in a separate building on a solid foundation.

The machinery will handle 90 tons of coal per hour. One of the track hoppers is used exclusively for anthracite and the other for bituminous, which makes it unnecessary to change the angle of the feeding chutes. The lump anthracite is stored in certain bins in the pocket and the bituminous in others. When it is desired to store the mixture of bird's-eye or rice anthracite and bituminous, the two automatic feeding chutes are run simultaneously, the hand wheels being adjusted to deliver the desired amount of each to each bucket in the elevator. When the buckets are dumped on the horizontal conveyor the two kinds of coal are thoroughly mixed. The 14 bins are sloped at the bottom toward each side of the pocket and engines can be coaled from any one of the 28 chutes provided. Four engines may be coaled simultaneously on each side of the pocket and the time required is from 2 to 4 minutes.

A conveyor plant on the New York Central at Syracuse is shown in elevation and section in Fig. 194. This station is designed for coaling locomotives from overhead storage bins, and is built entirely of timber with the exception of the beams carrying the tracks over the conveyor tunnel. It has four storage bins with a combined capacity of 820 net tons "run-of-mine" bituminous coal. Three of the pockets discharge directly into tenders of locomotives. The fourth, containing 265 tons, is held as an emergency supply and discharges through a chute into a conveyor delivering into the bins used for daily supply. The conveying machine is of the "link-belt" design, consisting of an endless chain of 36-in. by 26-in. buckets. The elevating capacity is not less than 80 tons of "run-of-mine" bituminous or anthracite coal per hour. The conveyor passes under all tracks through a tunnel, up on one side of the structure, over all storage bins and down on the other side of the building. The two coal-car tracks are provided with large track-hoppers through which coal is automatically fed to the conveyor buckets, these automatic feeders being so designed as to deliver the exact amount of coal to fill each bucket as it passes, without waste.

Provisions have been made for storing 96 tons of dry sand in an overhead pocket from which it is delivered to locomotives on either track through flexible sandspouts. The sand is raised from the track level in steel buckets, on a belt conveyor, the elevating capacity being 20 tons of dry sand per hour. The sand bin is separated from the coal

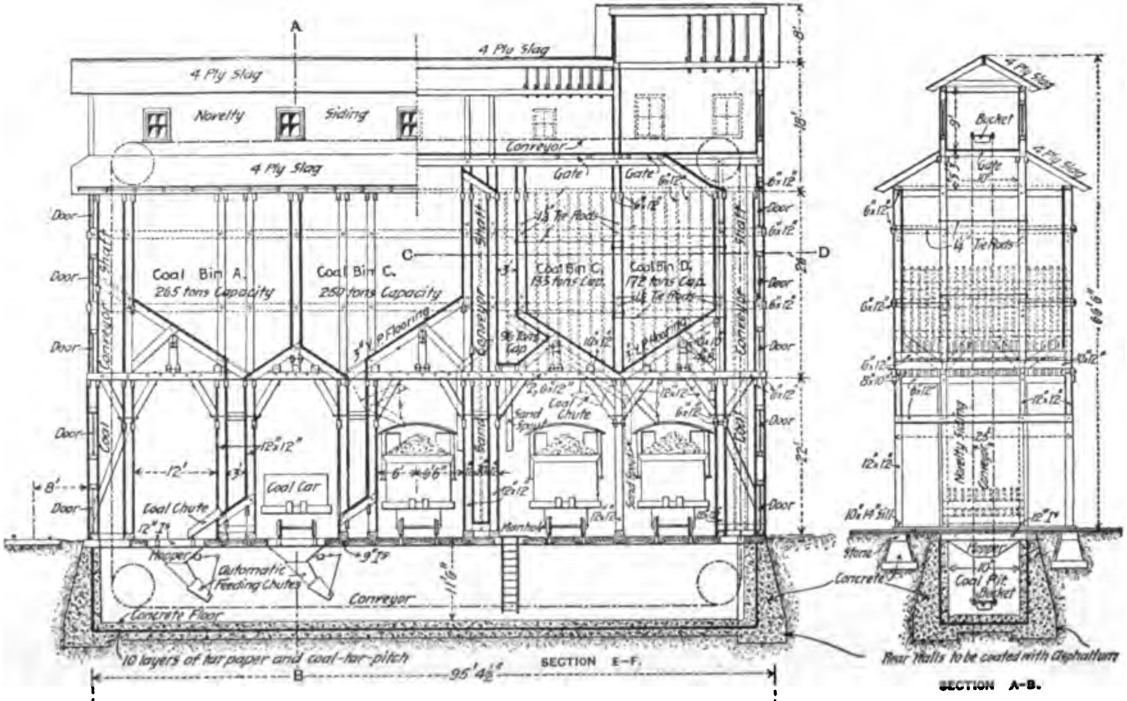

Fig. 194.—Coaling station at Syracuse, N. Y.—New York Central.

bin by partitions containing 12-in. air spaces, in which are located steam pipe coils to prevent moist air from reaching the dry sand.

Winch heads are provided in each coal track for drilling coal cars. Any water which may accumulate in the conveyor tunnel is removed by a direct-connected electric pump. The entire plant is operated electrically on a direct current of 500 volts, and is lighted throughout by electricity. Eighty locomotives per day take coal and an average of 360 tons is delivered. The cost does not exceed 3.5 cents per ton handled. Engines are coaled and take sand at the same time. Both operations are completed, ordinarily, in about a minute.

For handling anywhere from 6 to 30 or 40 engines a day, there is in use on the Pennslyvania at Elmira, N. Y., Williamsport, Pa. and other places, a method of coaling locomotives that is old but difficult to improve upon for the special purpose for which it is intended. Coal is dumped from hopper-bottom cars on a trestle just high enough to give clearance to a small car of metallic construction, running on a narrow-gage track under the trestle, each car having a capacity equivalent to that of the average tender to be coaled—about six tons. At these points the older and smaller engines predominate. When the small car is loaded it is run on a lift which by compressed air power is elevated in a vertical runway to a point where gravity clutches, or chocks, hold it and from which the contents of the car are dumped into the locomotive tender. The small car is built to be dumped by tripping. Compressed air is used because it is usually convenient, but electric or other power may be substituted. At points where no other power is convenient, a very ingenious arrangement consists of a system of pulleys and cables by which the locomotive to be coaled, lifts the platform on which the small loaded dump car has been placed. The locomotive is coupled to the end of a cable at a point on the approach track to the coaling lift. It is then moved forward a sufficient distance to lift the platform with the small loaded coal car to the desired height. At this point the platform is automatically caught and held. The lift, length of cables, etc., are so planned as to bring the tender just opposite the platform in position for coaling, when the platform is elevated sufficiently for that operation. The construction of a plant of this kind is not expensive and the cost of operation small.

A typical plant, of the covered trestle type, is shown in Fig. 195, that of the Chicago and North Western at Chicago. Essentially, it employs 24 "link-belt" undercut gates and hooded chutes, being particularly designed and adapted to the coaling of locomotive tenders of varying heights, with run-of-mine coal and to avoid overflowing.

In Figs. 196, 197, 198 and 199, are shown perspectives on stub-end and approach end; side elevation and cross-section of the Elizabethport, N. J., coaling plant of the Central of New Jersey.

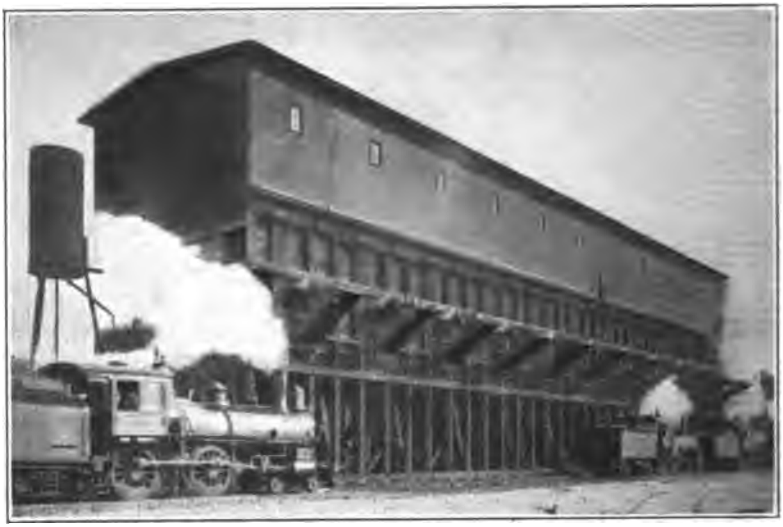

FIG. 195.—Coaling plant at Chicago—Chicago & North-Western.

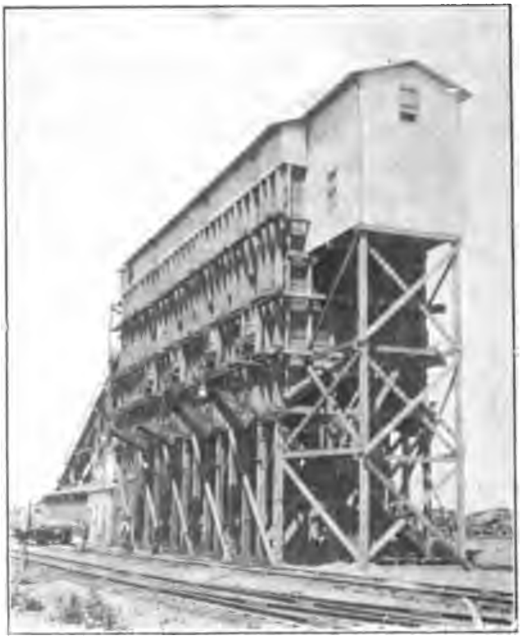

FIG. 196.—Coaling plant at Elizabethport, N. J.—Central of New Jersey.

This is of 800-ton capacity, is built of timber and includes sand pocket. The coal pocket has partitions for the division of the several kinds of coal to be stored, and is provided with eight coal chutes, four on each side of the building. These chutes are operated from the engine tender. There are two sand chutes, one on each side of the sand pocket. Two 24-in. belt conveyers are used, which have a three-sixteenth pure rubber cover at their centers. The conveyor "A" is 35 ft. between centers and is driven by a 5-h. p. D. C. Sprague motor. Conveyor "B" is 240 ft. between centers and is driven by a 30-h. p. motor. The coal is discharged from hopper bottom cars into the track hopper, dropping down over a grizzly to a short conveyor "A" which dumps at right angles on the long conveyor "B" which, in turn, discharges into any part of the coal pocket desired by means of an automatic tripper. Any lumps of coal larger than 8-in. in diameter drop on a shaft at the lower end of the grizzly where they are broken up and fall on the conveyor "A." The troughing, return and guide idlers are of cast-iron and run on hollow, cold-drawn steel tube shafts. These are lubricated by means of patent compression grease-cups mounted on their ends. The tripper is of an automatic reversible type, and can be operated automatically by means of a lever on the side of the tripper and stops placed on the rails, or by hand from either side of the machine, the power being taken from the conveyor belt in both cases. The tripper can also be made to operate in a fixed position by throwing out the automatic attachment and clamping

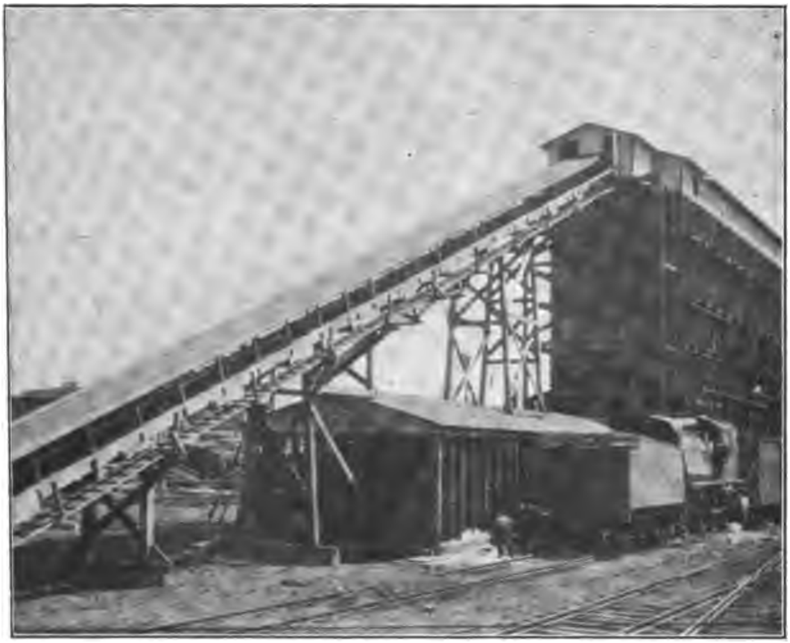

FIG. 197.—Conveyor Incline, Elizabethport coaling station—Central of New Jersey.

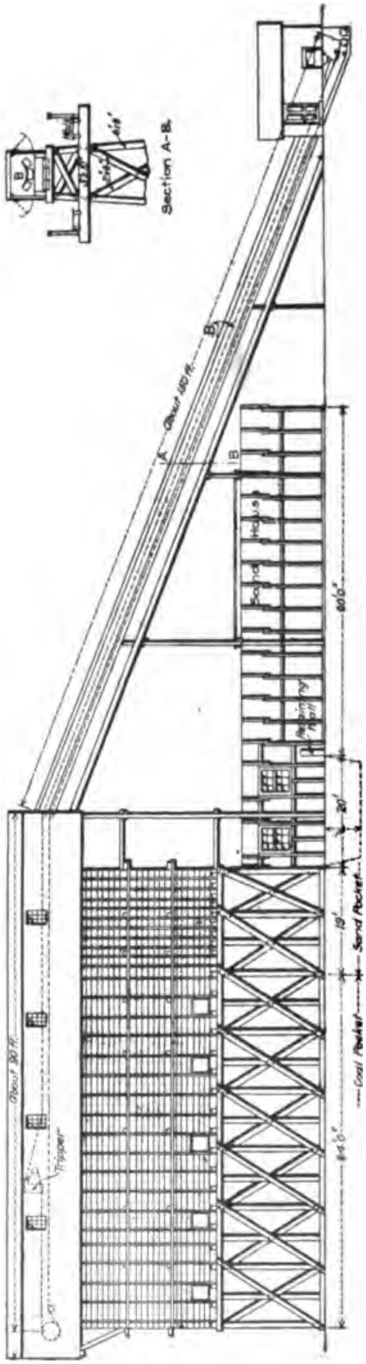

FIG. 198.—Side elevation of Elizabethport coaling plant—Central of New Jersey.

the machine to the rails. The carrying portions of the belts are kept clean by means of automatic rotary brushes. The driving pulleys at the conveyor ends have extra high crowns and are secured to the shafts by both keys and set screws, as are also the cast-iron gears. The track hopper and chutes are of yellow pine lined with steel. The sand pocket is lined with Paroid roofing paper and the floor is of 1.5-in. planks, doubled, with roofing paper placed between. The plant is electrically driven throughout, and the speed of the conveyor belt is 377 ft. per minute.

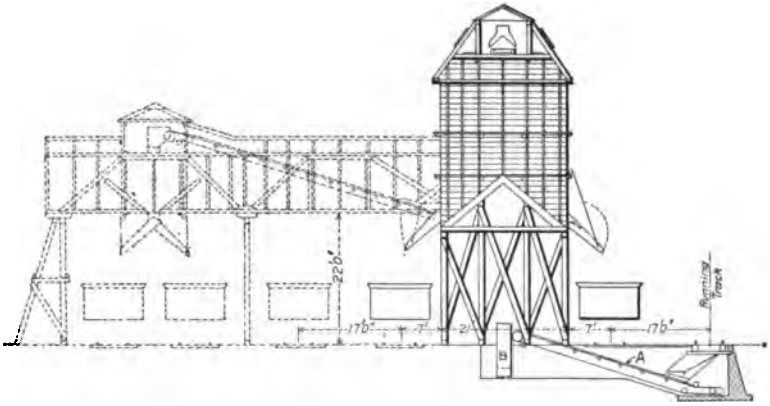

Fig. 199.—Cross-section of Elizabethport coaling plant showing proposed extension—Central of New Jersey.

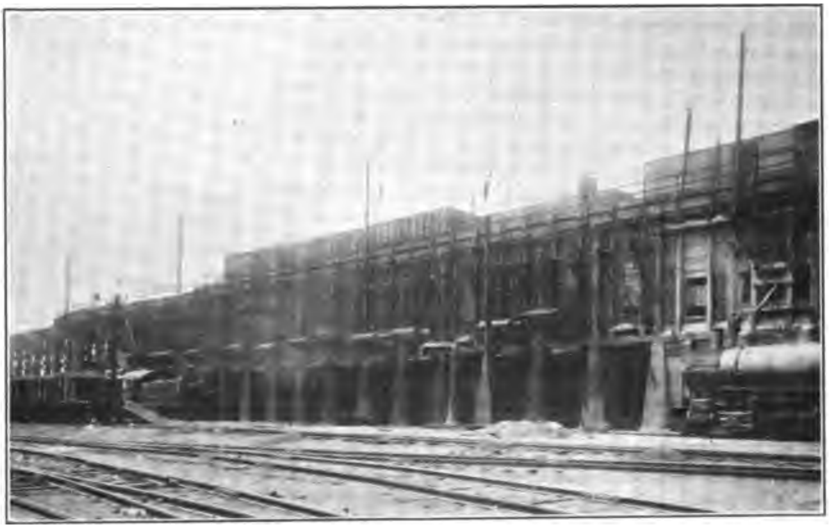

Fig. 200.—View of coaling plant, East Altoona—Pennsylvania Railroad.

The view shown in Fig. 200 and plans in Fig. 201 are of the Pennsylvania coaling plant at East Altoona, Pa. The diagram, Fig. 184 on page 400, is self-explanatory. If an incoming engine needs no attention in the house it has the fires cleaned over the ash-pit, takes coal, water and sand and is run around the house to the east end of the yard, turned and run in on the storage tracks to await call. The four ash-pits are 240 feet long and accommodate four engines each, or 16 in all; eight for the Pittsburg division and eight for the Middle division. They are located about 280 ft. beyond the inspection pits, two on each side of the coal wharf. The track leading from the inspection pit turns out to two tracks spaced 30 ft. 4 in. center to center, which is the spacing at the ash-pits. This allows room for a stub track for ash-cars between the pits. A second ash-car stub track is laid next to the outside pit and an overhead traveling crane of 61-ft. 6-in. span covers all four tracks. This crane runs on a steel runway extending the entire length of the pits and has a capacity of 5 tons. The electric hoist has a speed of 85 ft. per minute, the trolley 150 ft. per minute and the bridge 400 ft. per minute. The operator's cab is hung from the bridge close to the runway at one side. The runway has 11 bents and is high enough to give a clearance of 21 ft. under the center of the bridge.

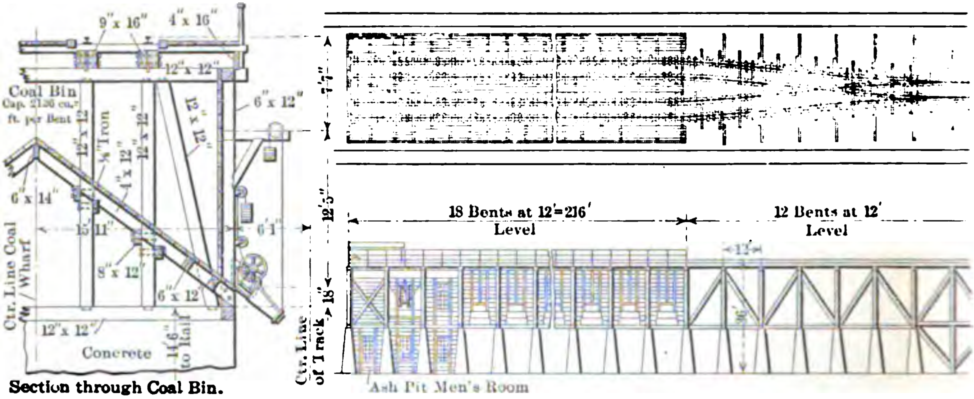

FIG. 201.—Coaling plant, East Altoona, Pa.—Pennsylvania Railroad.

The pits are about 4 ft. deep and 4 ft. wide between the 12 in. by 6 in. oak stringers on which the rails are laid. The walls are of hard-burnt brick and the floor and foundations of concrete. In the bottom of the pit a narrow gage (2 ft. 4¾ in.) track is laid on timber stringers to carry the ash-bucket cars. When an engine is run over the pits three of these buckets, which have a capacity of about 48 cu. ft. each, are run under it, one under the front end and two under the ash-pan, and the cinders and ashes are dumped into them. After the fires have been cleaned and the engine moved off of the pit the ashes are wet down in the buckets;

the crane picks them up and dumps them into the ash-cars on the adjacent stub tracks. The pits drain to sumps with perforated covers and removable perforated linings. These sumps extend 2 ft. below the center of the 10-in. drain pipe and all cinders washed down settle in the removable lining at the bottom, where they can be easily removed at frequent intervals.

The standard form of coaling trestle used on the Pennsylvania is shown in Fig. 202. Such a plant is cheap to build and operate. The sketches convey a very good idea of its construction.

The conveyor system may be advantageously utilized where available ground space does not permit of an inclined approach for raising the coal

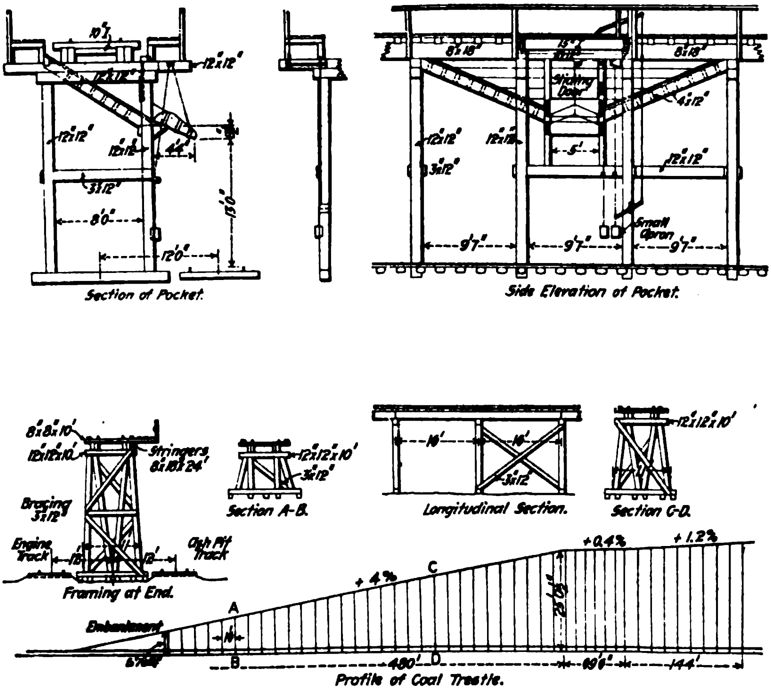

FIG. 202.—Standard coaling trestle—Pennsylvania Railroad.

in standard gage cars. By using a conveyor, but little more than half the ground space is needed as for an inclined approach, gravity dump or barrow coaling plant of about the same capacity.

The coaling station of the Lake Shore & Michigan Southern at Elkhart, Ind., extends across six tracks. It consists of a steel supporting structure carrying the weighing bins and hoppers and a wooden super-structure.

Records of coal dumped, furnished locomotives, etc., should so far as practicable, be kept without imposing much, if any of the clerical work on enginemen, firemen or hostlers. Where these men are required to do much of this kind of accounting it not only takes their minds from more important work but records are inaccurately kept and consequently are unreliable. Very few roads are so equipped to keep a fairly accurate record of coal consumption, and to make an equitable distribution of it. The "adjustments" at the end of the month or other time period are depended upon to balance the accounts. An engineman, fireman or hostler cannot be expected to estimate even approximately the amount of coal he leaves in a tender or the amount he finds there when he takes charge of the engine. Where the coal is dumped by gravity into the tender, a "guess" is made, which is usually far from accurate. In the absence of arrangements for weighing or measuring, the discrepancies are great. Where the barrow system is used—a barrow usually containing a ton—the amount may be more closely figured on, but that too is unreliable. The coal is then bought by weight and charged out by volume. Considering all the uncertainties, the most satisfactory system is that requiring the foreman at the coaling plants to keep the records of coal furnished. Enginemen, and others in charge of engines should not be asked to do anything beyond possibly certifying to the coaling plant foreman's ticket as to the amount of coal supplied.

An investigation of the cost of handling engine coal from the cars to the engine, on different railroads by different systems of coaling appliances, has recently been made, and the maximum, minimum and average figures are tabulated below:

ACTUAL COST OF HANDLING COAL FROM THE CARS TO THE ENGINES AT VARIOUS PLANTS

(No allowance for interest and depreciation on first cost)

			Cost per ton in cents		
Method of coaling	No. of plants averaged	Tons of coal handled daily	Minimum	Maximum	Average
By hand from cars,	12	3 to 12	5	14	10
By hand from cars,	5	24 206	12	20	15
By trestle (no repairs),	5	4 55	5	13	9
By trestle (no repairs),	7	127 346	2.7	8	5
By elevator (no repairs),	3	73 212	3.3	6.25	5
By belt conveyor (includes repairs)	18	15 1053	2	6.25	4.25

Inasmuch as the cost varied a good deal for the same type of coaling station, when the daily quantities of coal handled differed widely, an estimate of the cost of coaling from different types of stations when of the same capacity, 700 tons per day was made, including in the items an allowance for interest and depreciation on first cost, and repairs. The figures are based for the most part on actual cost at stations of each of the types.

COMPARISON OF VARIOUS TYPES OF COALING STATIONS—ESTIMATED COST OF HANDLING COAL PER TON BASED ON A DAILY CAPACITY OF 700 TONS

(Includes interest, depreciation and repairs)

Method of coaling		Cost per ton in cents.	
		When handling 50% of rated capacity	When handling 125% of rated capacity
Should use self-clearing cars	Inclined trestle,	4.1	2.8
	Holmen bucket elevator,	3.9	2.6
	Belt conveyor,	4.5	3.0
	Belt cross conveyor,	5.2	3.9
Al hand shoveling	Steam cylinder car hoist and platform,	8.75	7.25
	Car hoist and platform,	12.3	10
	Platform and trestle,	10 to 17	8.5 to 14
	Platform, bucket and hand crane,	11 to 15	9 to 11

In 1885 a committee of the Roadmasters' Association investigated the costs of handling coal by the different methods in use. For handling over platforms of different constructions the maximum was 30 cents per ton and the minimum 11 cents, with an average of 19.4 cents. For coal chutes the maximum was 9 cents per ton and the minimum 4.5 cents, the average being 7.4 cents. The average saving in favor of the chutes was therefore, 12 cents per ton. The time consumed in taking coal from the chutes was one minute and from other devices 12 minutes —a saving of 11 minutes per engine coaled, in favor of the chutes. Where 3000 tons were handled monthly there was a saving in favor of the chutes of nearly $4500.

Costs based on experience are always interesting. The Erie, after handling 40,000 tons with a crane and clamshell bucket, reports a cost of two cents per ton for placing it on engines. Two crane engineers, two firemen and two men on the ground, were employed. At Hammond, Ind., this road loaded coal and ashes at a cost of 5 to 7 cents per ton for the coal. The Chicago & Western Indiana at Chicago 47th Street engine-house, handled 9000 to 10,000 tons a month at 7.6 cents. This cost included wages of shop yardmaster, one-half of hostler's time for handling shop engines, two clamshell operators—one day and one night—switching coal and cinder cars and the repairs of the clamshell.

Other locomotive crane handling plants show the following cost:

Location	Buffalo	Leipsic	Bellevue	Ft. Wayne	Conneaut	Stoney I'd	Cleveland	Mina.
Year	1905	1905	1905	1905	1905	1905	1906	1906
Average tons per day	176	116	230	153	106	45	166	218
Fixed charges...(cents)	1.9	1.7	1.8	1.8	3.7	7.9	2.0	1.5
Operating charges..."	4.7	6.1	3.6	5.1	3.0	5.5	5.5	3.5
Maintenance charges"	0.5	0.2	0.7	0.5	0.4	0.2	0.3	0.1
Pro rata charges...."	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total charge per ton	7.5	8.4	6.5	7.8	7.5	14.0	8.2	5.5

One disadvantage of open-air storage in pockets or pits, however, is the liability of the coal and gates being frozen up in cold weather. With the necessary tracks, pits and pockets, it will be found that this kind of plant has a considerable first cost. Its operating cost depends upon the work which can be provided at spare times. Its value is great in emergency situations and at points where, because of impending changes, the construction of a permanent plant is unwise. With a large terminal where a conveyor plant is used, a locomotive crane may be very valuable to handle cinders and sand and also coal, during a possible breakdown of the conveyor. Then again not only can it unload direct from flat-bottom cars, handle ashes as well as coal, move to any spot where it is desirable to stop the locomotive, but if superseded by a different system, can be easily moved to another point and utilized for the same or similar purpose. These cranes are always in demand at shop plants, for lifting and conveying heavy pieces of machinery, and in freight yards to aid in loading or unloading heavy articles of freight.

In 1902, a committee of the American Railway Engineering Association considered carefully the question of coaling stations. A list of the principal factors to be considered in adopting a method, given in that report, is well worth reproducing:

1. The question of location is one of the most important for consideration. This will be governed by the convenience as to the operation of the business of the railroad. At terminals and at junction points it is probable that large coaling plants will be desired; but at intermediate points on the line, coal must be supplied to locomotives hauling freight and passenger trains. The location may determine largely the nature of the plant to be used. Where large quantities of fuel are to be handled with only a limited amount of room for the construction of tracks and buildings, an expensive plant may be fully justified. At other points where land values are small, a totally different style of plant may be the most economical.

2. The quantity of coal to be handled will also largely influence the character of the plant to be built. Where but one or two car loads of coal per day are required, it is doubtful whether anything but the simplest plant should be built that is sufficient to permit delivering the coal required in the least possible time. On the other hand, where from 200 to 400 tons per day have to be handled, expensive plants, well-designed machinery and first-class construction will be justified.

3. A third consideration is the cost of operation. This touches upon the labor question, involving the consideration whether steam engineers, machinists and expert mechanics, or crude day labor shall be utilized in connection with the operation of the plant. In some parts of the country, day labor may be had at approximately one-half the rates which are demanded in others. The rate of wages to be paid to the laborer will be an important item.

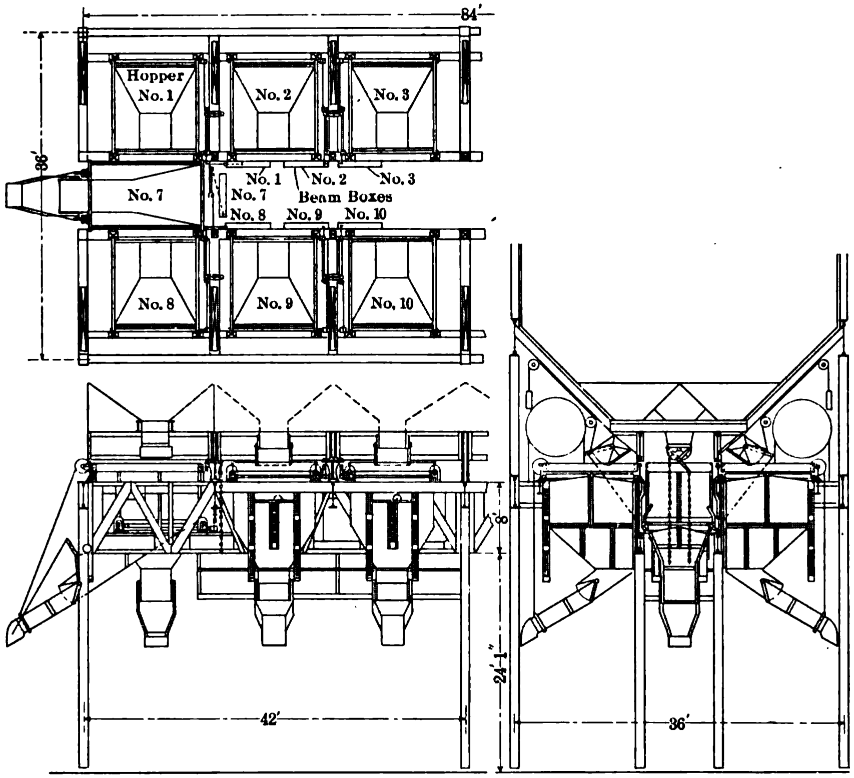

FIG. 203.—Coaling station of St. Louis Terminal Association.

4. A fourth consideration will be the amount of first cost, and also the cost of repairs and renewals. It is evident to make a true comparison of the economy of different plants, these items should be reduced to a measure of cents per ton of coal handled, rather than to make a comparison of the gross amounts of actual cost and maintenance.

5. In the same connection, a true comparison will require a consideration of the interest on the cost of the investment, and this also should be reduced to an equivalent value of cents per ton of coal handled.

6. Complicating all of the above is the question of storage. That this is a matter of great importance, and that it usually receives but little consideration, is evident from the amounts which are annually spent in storing coal on cars and holding the same on side-tracks at coaling stations, rather than constructing suitable storage bins in which the coal may be kept, thus liberating the cars for commercial business.

7. The kind of coal handled will also influence the decision—whether it be anthracite or bituminous, or both, inasmuch as the appliances which are efficient for one kind may be less so for the others.

8. The facilities which each company has for delivering coal to its coaling plants will tend to make the situation more involved, since coal may be handled either in box cars, gondola cars (with stationary or with movable sides or traps), side-dumping or bottom-dumping cars, and other varieties, each of which will have its own influence on the special modification of plant to be adopted for economy.

The plant of the St. Louis Terminal Association, shown in Fig. 203, is another good example of the conveyor type. It has a storage capacity of 1000 tons and is so arranged that seven locomotives can take coal, sand, water and discharge ashes at one time; and 21 locomotives may be cleaned simultaneously. The average number of locomotives handled daily is about 200. The 13 auxiliary pockets, capacity 15 tons each, are mounted on registering beam scales.

CHAPTER XXIX

ASH AND SAND PLANTS

The ash pans of a 100-ton freight engine, burning anthracite and bituminous coal mixed or straight anthracite, will, after an average run with its full tonnage rating, contain from 1.5 to 2 cu. yd. of ashes and clinkers. An engine of the same size burning bituminous coal will yield from 60 to 70 per cent. of that amount and will be very much easier to clean, as the ashes are lighter and will run out more readily. As there is perhaps no engine terminal which handles but one type or class of engine, an average weight may generally be figured on for the total number of engines at anywhere between 50-tons and 100-tons. This will give an average weight for all engines of between 75 and 90 tons each; it being assumed that the heavier engines predominate and that the proportionate number of such engines in service will increase. At a plant handling from 75 to 125 engines daily, or say 100 engines per day throughout the year, from 100 to 125 cu. yd. of ashes will be made and must be cared for on an anthracite road, and probably 80 to 100 cu. yd. on a bituminous road. This quantity will fill six to seven or five to six ordinary open cars, respectively. It is assumed that old, light capacity, low-side coal cars are used, and that they are usually not very fully loaded. Cars which stand opposite points on the ash tracks where few fires are cleaned may get away with a light load.

The fire of an engine burning bituminous coal may, under favorable conditions, be cleaned in from 10 to 15 minutes; running up to 30 minutes for the large engines. A small engine burning a mixture of anthracite and bituminous or straight anthracite will require 20 minutes to clean the fire; with the large engine the time will run from 30 to 40 minutes. There is hardly any limit to the time that may be consumed in freezing weather when the engine has been run through snow. Where no special arrangements are provided, it may take, and, in extreme cases, has taken three or four men as much as four hours to get an engine ready. With the assistance of steam pipes or furnaces to thaw out the hopper slides and the ashes in the hoppers it may run up to one and a half and two hours. When engines leak so as to have water in their fire boxes the difficulty is increased. Leaky fire boxes and flues are among the aggravating conditions which accompany the already unfavorable combination of cold and stormy weather and increased demand for motive power. Men will not and cannot do their normal amount of work when the thermometer is at or below zero and accompanied by a high wind, with perhaps snow and darkness contributing further to the difficulties

The photographs in Figs. 204 and 205 are of "Brownhoist" eight-wheel coaling crane, Erie Railroad, Cleveland, Ohio; and four-wheel crane, the Nickel Plate, Bellevue, Ohio, respectively. The view of the Cleveland crane shows ash pit and track arrangement. The coal being taken from the car is deposited in the tender; the crane also takes ashes

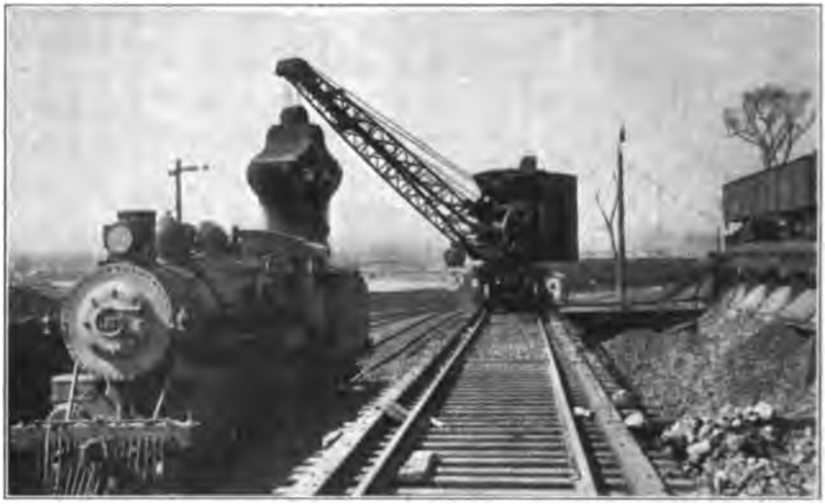

FIG. 204.—Coaling and ash-track arrangement at Cleveland, Ohio—Erie Railroad.

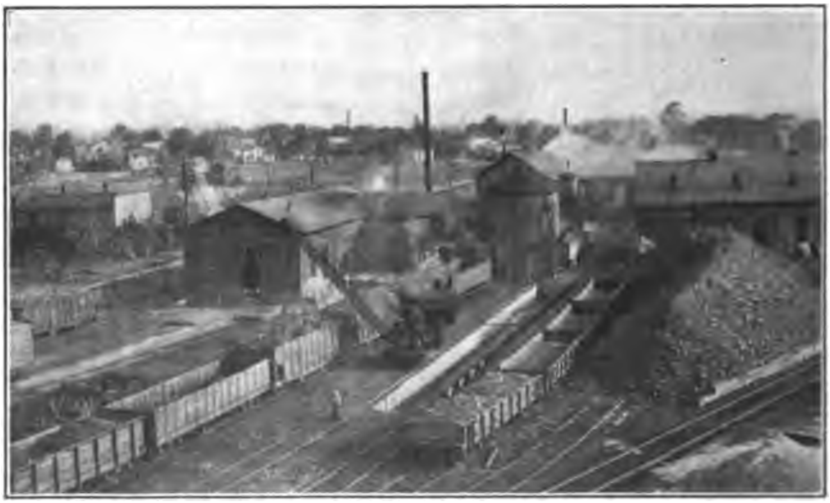

FIG. 205.—Ash-track arrangement at Bellevue, Ohio—New York, Chicago & St. Louis.

from the pit and deposits them in cars on adjacent tracks. The Bellevue cut shows arrangement of tracks and ash pit.

The kind of ash track to be built depends on:

1. Number, kind and size of engines to be handled.
2. Kind of coal used.
3. Weather conditions existing when the maximum number of engines must be handled.
4. Physical characteristics and property limitations.
5. Distance ashes are moved.
6. Amount of appropriation available.

Where the number of engines to be handled is small, a cheap arrangement, or even no arrangement beyond a spare track on level ground, may prove an economical one.

The following table gives the approximate cost per lineal foot of different forms of ash-pit construction with a foundation depth of 5 ft. below top of rail:

Form	Price
Ordinary brick or stone wall, stone coping, rails fastened with spikes in wooden dowels........	$5.00
Same, rails fastened with nag bolts.............	5.25
Same, with iron bearing plates.................	5.50
Ordinary brick or stone wall with small cast-iron chairs built into the walls or set as top of wall..	6.00
Ordinary brick or stone wall, timber coping, rail fastened to wrought-iron plate over the timber.	6.25
Same, with cast wrought-iron covering over top of wall....................................	6.75
Same, with large cast-iron rail-chairs, filled in between the chairs with stone or brick work...	9.25
Same, with large cast-iron rail-chairs and cast-iron ties across the bottom of the pit connecting the rail-chairs, the side walls being left open between the rail-chairs.............................	10.75
Shallow, all wrought iron pit	6.00 to 8.00
Deep; all wrought iron pit	9.00 to 11.00
Add to above for fireproof protection of the side walls......................................	1.00
Add, if bottom of pit is made of fire-brick instead of ordinary paving	1.00

If an average of 70 or more engines are handled each day, the decreased cost of handling will justify an initial expenditure of sufficient money to construct a serviceable ash track.

The writer planned an ash-handling plant for a heavy terminal where a structure of considerable height and necessarily of fireproof construction enables the engines to be run thereon and the ashes dumped vertically into metallic-body cars standing on an ash-car track directly underneath. This necessitates a span or opening through which the cars could be run under the track on which the engines stand; and preferably an entrance at each end to enable the empty cars to be shoved in from one end and the loaded cars taken out at the other end. Although the plant might be handled with an entrance at one end only, such plan would increase the cost for switching and lengthen the intervals between the placing of cars. The operation of such a plant may be greatly simplified by using gravity, the empty car track being on a grade sufficiently heavy to permit the cars to be dropped into position and the loads dropped out of the way. If a gravity empty-car track is not put in, other cars must be used to reach those to be taken out. The clearance on the low track, as a matter of course, cannot be made sufficient to permit an engine to go under the high track. This plan may seem expensive, but anyone who has knowledge of the actual cost of handling ash plants, will not hesitate to recommend a comparatively large amount in first cost to enable engines to be handled afterward economically and expeditiously.

Ashes were handled by a locomotive crane at different points with following results:

No. of locomotives cleaned per day	20	26	12	5
Cost per locomotive cleaned,	4.8	3.8	3.3	4.7 cents.

At one fairly well-equipped engine terminal, 170 engines a day are handled over four ash pits. An inspection pit is located so that engines passing over it can reach any of the ash pits. Eight inspectors are on duty at a time; an engine is thoroughly inspected in three minutes. A record was once made of 19 engines on the pit in 57 minutes during a rush movement.

Unfortunately, the "bill of expense" for handling ashes seldom, if ever, tells the whole story, and consequently railroad managers serenely permit the leaks to continue. If the maintenance of way department uses or can use the ashes, the expense of loading and unloading is shifted to it. It may, then, be charged under one head or another, according to the views or intelligence of the section or work-train foreman, or the extent to which expenses may be watched in some one particular direction and neglected in another.

There is always a hobby somewhere in charging expenses. An instance is recalled where a general officer in charge of the transportation department peremptorily declined to permit the maintenance of way department to use any more old style hopper-bottom coal cars for handling ashes. It became necessary, therefore, to shovel out of solid-bottom cars at great cost. The hopper-bottoms were either used in the lumber trade and in other business for which solid-bottom cars were suitable or else side-tracked awaiting business that might be offered "some day." Somebody paid the bill. This is only one of many instances, in actual practice, where the cheap plan costs the most, or where short-sighted operating managers, while ostensibly guarding the railroad interests closely, are in reality causing the biggest kind of leaks.

The writer cannot recall an ash track of the overhead type in actual use, but is unable to see a real objection to it. All arguments as to expense may be met. No men would be needed to transfer the ashes to the cars, beyond the regular hostlers and helpers, or "fire-cleaners." The best plan of ash tracks in use necessitates the employment of two men to shovel, day and night, to take care of 60 or 80 or more engines. At $1.25 a day, which is a very low rate of wages for this kind of work, an expense of $5 a day, for labor is necessary, or $1825 a year. Capitalized at 5 per cent. it represents a principal of $36,500. Allowing for deterioration of the plant, it would seem safe to spend $20,000 over and above the amount necessary for any other good type of ash track where enough engines have to be handled to make it remunerative.

It will be urged that this kind of a layout necessitates the use of a special construction of metallic car. Admitting that old cars cannot be used by lining their bodies inside with iron from worn-out tenders, that not even the trucks of dismantled car-bodies can be used, and that it is necessary to purchase outright new metallic body cars to be assigned to this work, the difference between the value of the old wooden cars ordinarily used and the new cars is the extreme amount of be charged against the new plant. This leaves out of consideration the frequent loss due to the wooden bodies burning out by hot ashes. Assuming six cars to be needed for a day's loading and two days for unloading it will require 18 cars. If the unloading point is close at hand 12 cars, or two shifts, will answer. This may, however, require special engine service and prevent utilizing the ashes at the points where most needed. It is better to figure on three shifts, or 18 cars, of which one shift would be at the ash track loading; one on the way out in a local freight train being unloaded and the other on the way back empty. Taking the cost of new cars of light capacity and small bodies at $800 each and the value of the old cars at $400 each, an expense of $400 per car or a total of $7200 is properly chargeable against the overhead type of ash track as against the side-loading method. The metallic ash car assigned to ash-track work and arranged to dump readily at either the side or bottom is a good investment for any point where many engines are handled. With the metal self-unloading cars, the regular train crew can dump the cars, where desired, provided the section men level them off. If side dumps are used even that provision is unnecessary. With the ordinary car, a work train is needed or at best a section gang for say, half a day.

An excellent arrangement for an ash track at points handling heavy business is that of an engine track alongside of and at sufficient height above an empty car track to enable a slope, or series of side chutes, to be used in such a manner as to carry the ashes directly into the cars. The assistance of a stream of water, or raking where the ashes would stop and clog, would be all the aid needed to load them, aside from the occasional "trimming" of the cars. The incline, or chutes, would have an overhang at the lower end to carry the ashes well over and into the cars. A platform on each side of the engine and at about the level of the rail is necessary for the cleaners to stand on while working on the hoppers.

A good plan and one in very general use, is similar to the last with the exception of the incline arrangement. The floor of the ash track, level or slightly inclined, of masonry construction, is a little higher than the top of the car standing on the depressed track alongside, to enable a hinged metal apron to be thrown across from the ash-track floor and rest on the top of the side of the car. The engine track rails are carried on cast-iron columns about 22 or 24 in. high, placed about 36 in. apart, under each rail. In some plans the rail on the side away from the depressed track is carried on masonry. The track should preferably be long enough to give room on the depressed track for a sufficient number of cars to take care of 24 hours' output of ashes. Where the track is shorter more switching service becomes necessary. If the location permits, the depressed car track should be on a descending grade to enable the loaded cars to be dropped away and empty cars placed without the use of a yard engine.

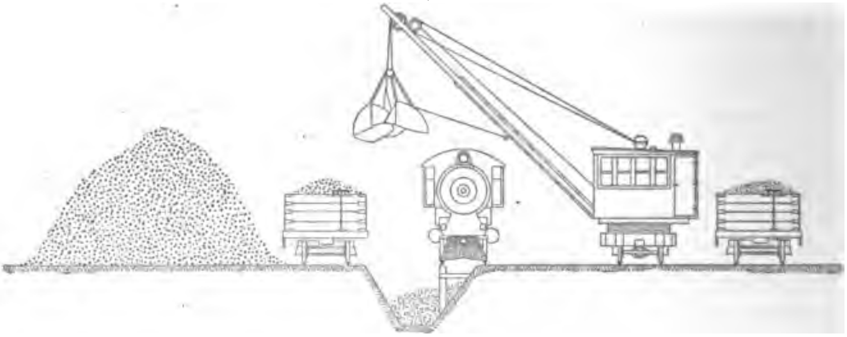

FIG. 206.—Power crane, coaling, storing and handling ashes.

A method largely in use on one trunk line is that of a pit under the engines containing ash buckets which are lifted out by a crane or a compressed-air cylinder moving on a transverse crane. The bucket is carried directly over the empty car, into which it is dumped by tripping the hinged bottom. In some cases the buckets have small wheels under them running on a small track in the bottom of the pit. The bucket may then be readily run from the point where it received the ashes to the crane for dumping and from the crane, empty, to the point where the engine is to empty its hoppers.

One cinder conveyor for an ash track consists of an iron car running upon an incline track which enters the ash pit at the side. This incline track extends laterally over a depressed track which is parallel with the pit and 18 ft. distant, center to center. The ash car is hauled up the incline by a cable and compressed-air cylinder, and as it arrives over the depressed track, on which the receiving car stands, its bottom is automatically tripped and the ashes dropped.

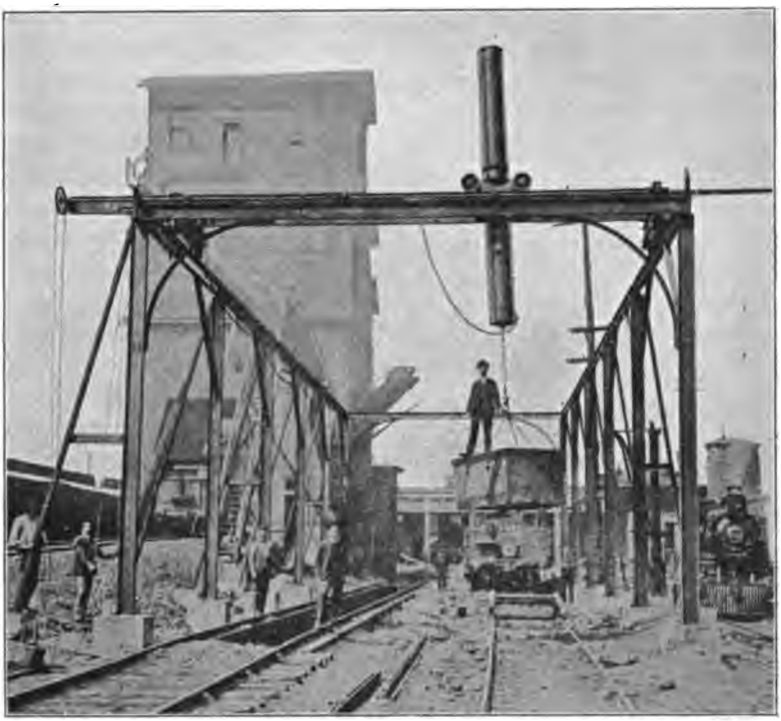

FIG. 207.—Pneumatic ash-handling plant for the Baltimore & Ohio.

The cross-section diagram in Fig. 206 shows the adaptation of a locomotive revolving crane being utilized for coaling engines, from cars or storage, and taking ashes out of the ash-pit and loading them onto cars.

Fig. 207 shows an ash-handling plant built for the Baltimore & Ohio. It consists of a steel runway 95 ft. long, supported on steel columns securely braced laterally. On this runway is a 2.5 ton, direct-acting, air-hoist traveling crane of 28-ft. span and a lift of from 12 ft. to 16 ft. It is moved along the runway by means of hand chains and the travel of the trolley on the bridge is accomplished by the same means. The entire structure is designed to handle full loads with a factor of safety of five. The crane, bridge and trolley are fitted with roller bearings and the wheels have machined treads to make the travel as easy as possible. The traveling chain on the bridge projects beyond the runway, but this chain can be located wherever desired on the bridge. The hoist is direct acting and is mounted on a universal swing bearing on the trolley. The working pressure is 80 lb., the air being conveyed to the hoist by hose, carried along the runway on small hose trolleys over which it is looped.

In operation the ashes and cinders are dumped from the locomotive into large metal ash boxes in the ash pit. These boxes are lifted out by the crane and placed on a flat car alongside. The plant is cheap to build and operate. If preferred the bridge and trolley can be moved by air motors, and for those roads having electric power, electrically-operated plants can be supplied. These are more compact than the pneumatic plants. The builders supply the runway in any span and length required, or the crane can be supplied alone, the buyer supplying the runway.

Two sets of ash tracks were put in for each of the engine-houses of the Lake Shore at Elkhart, Ind. That for the freight engine-house is 200 ft. long, and has two dumping-tracks in addition to two short pits for yard engines and other engines coming from the house which require their ash pans cleaned. The passenger pits serve two tracks and are 120 ft. long. The design for both is the same, a depressed center track with concrete walls and floor. The dumping-track is supported at the outer rail by a brick wall, and at the inner wall by cast-iron piers. There is a space between this and the wall of the depressed track, for the cleaners to stand on. All ashes are handled manually, there being space enough in the pit to clean a large number of engines, after which the men are used to shovel the cinders into cars on the depressed track. There are several water connections on either side of the pits and also a steam connection for melting out frozen ash pans.

From these suggestions, cheaper and simpler plants of somewhat similar types may be built for less important terminals. The system of columns described in the foregoing is frequently used without elevating the engine track beyond such elevation as is secured in the height of the columns and without depressing the empty-car track alongside. This necessitates shoveling and lifting all the ashes loaded and the removal of engines from the ash track, or a part of it, while shoveling ashes out.

Longitudinal stringers supporting the rails, with a slight depression between, the whole covered with fire-clay, make a cheap and efficient ash track to care for a small number of engines.

Engine failures are frequently due to engines going on to the ash pit with low water. Before going on the pit the boiler should be well filled and the engine kept in motion as much as possible while the injector is at work. Feeding water into the boiler while standing on sidings or over the ash pit will often cause flues to leak. If the engine is kept in motion it causes the water to circulate more freely and prevents it from going to the bottom. If the engine is taken to the pit with its boiler filled, the fire may be knocked out, dampers closed, front end cleaned, and then taken to the roundhouse without likelihood of leaks being started. When there is no work to be done on the engine, the fire should simply be cleaned and banked. When washing out of the boiler is necessary, steam should be blown off and the boiler cooled through the check or injector pipe, with the blow-off cock open. In no case should water be allowed to drop below the crown-sheet until the bare hand can comfortably rest upon the boiler head. Many road troubles of engines may be traced to the carelessness or incompetency of the handling at the ash pit.

Sand is used to increase the adhesion between the driving wheels of the locomotive and the rails, when required, and is at best a necessary evil. It is objectionable because it increases the wear on rails and tires and when carelessly used on interlocking connections clogs the movable parts and greatly increases the wear. On a bad rail—that is one slightly moist with water or grease or frost—its use will often prevent the stalling of a train or enable a standing train to start. Occasionally the too liberal use of sand,or carelessness in its application, will retard the train (by adding to the rolling resistance of the train) to an extent that will more than offset the advantage of increased adhesion.

On many roads enough consideration is not given to proper methods of supplying sand at the engine terminals and other places where it is required. The mistake is frequently made of not storing in the sand house (or nearby) in summer or fall a sufficient amount of sand to last during the winter. In the absence of such foresight it is usually frozen in cars when received during the winter and can only be unloaded at enormous expense. In many instances the engine-house forces are unable to unload the sand, or when unloaded it is hard to dry it properly.

There are many methods of unloading the green sand, drying it, elevating it to the supply point, and delivering it to locomotives. An elevated dry-sand arrangement, to enable the sand to be dropped into a locomotive sand box by gravity, has many features to commend it. It is possibly a little more expensive in first cost than when not elevated, but it is much less expensive to operate such a plant. There is less liability of the sand dropping on the guides, or other parts of the locomotive machinery, where its presence may produce bad results.

The green or wet sand bin should be large enough to hold the winter's supply. This is particularly desirable in cold climates where the cost of unloading and handling the frozen sand is high. The bins should be filled during summer or autumn when the sand may be handled readily, and when the car supply is more liberal and handling capacity of locomotives greater.

The ordinary sand-drying stove is hard to improve upon, unless the consumption is considerable. The cost of repairs is light and it can be maintained by ordinary labor. One such stove will in about 10 hours dry enough sand for 45 to 50 engines, and requires only the attention of one laborer, who may in addition be required to look after oil, supplies, etc.

Where sand-drying stoves are used, the ordinary method is to build bins opposite one or more such stoves for the green sand, and hoppers for the dry sand. An elevated track—usually the coal-plant track—is used to unload the green sand by gravity into the bins. The dry sand hopper is elevated sufficiently to permit the sand to be drawn from it by gravity through a spout inclining toward the engine on the side of the plant opposite the elevated track. The dried sand may be elevated into the hopper by use of compressed air, derrick or tackle, or a windlass arrangement. In some instances electric power, close at hand, is used to advantage. A gasoline engine may also be economical.

Side elevation and cross-section of the East Buffalo, N. Y., sand plant of the Delaware, Lackawanna & Western, are shown in Fig. 208.

The steam and drying bin is 6 ft. wide at top, 10 ft. long, with vertical sides extending 18 in. down from top. Below this, sides incline at an angle of 45 degrees to bottom, leaving 12 in. flat surface on bottom, with necessary opening for dry sand to pass through, detail of which is not brought out in plan. Three sets of one and a quarter gas pipe along each side and bottom of hopper, as well as through center of same, 9 ft. 6 in. long, with return bends, making 100 pipes on sides and bottom, and 31 in center, making a total of 131 in all. Underneath sand drying hopper is suspended galvanized iron hopper, the top of which is full length of dryer, and 12 in. wide, reduced to 12 in. square at bottom. The hopper sheet is on the two ends only, in which are placed screens for screening sand, leaving a space of about 3 in. between the screens and sides of hopper on the bottom, through which sand passes, leaving gravel to pass over the screen. Two outlet spouts are provided, one for gravel, which is diverted outside of the building, and another one for sand run by gravity to boot of elevator, where it is elevated into sand hopper, from which engines are supplied. The entire plant is 18 ft. wide, 62 ft. long; 25 ft. in length, of which is used for green sand 12 ft. for sand dryer and the remainder for elevator and hopper, as well as dry sand storage bin, which is located underneath the hopper. Track elevated 27 ft., where cars loaded with green sand are run and unloaded from drop-bottom cars through doors provided for that purpose in center of track; the bottom of green sand bin being elevated 11 ft. above the track or ground surface, or 16 ft. below base of rail of elevated tracks. Top of sand dryer hopper 18 in. above green sand bin floor. The outlet valve in bottom of dry sand hopper is cone-shaped, running to a point in a vertical position, and inserted into the outlet spout inside the bin when desired to stop the flow of sand, being operated by lever attachments inside, and from the top of the bin, with suspended chain

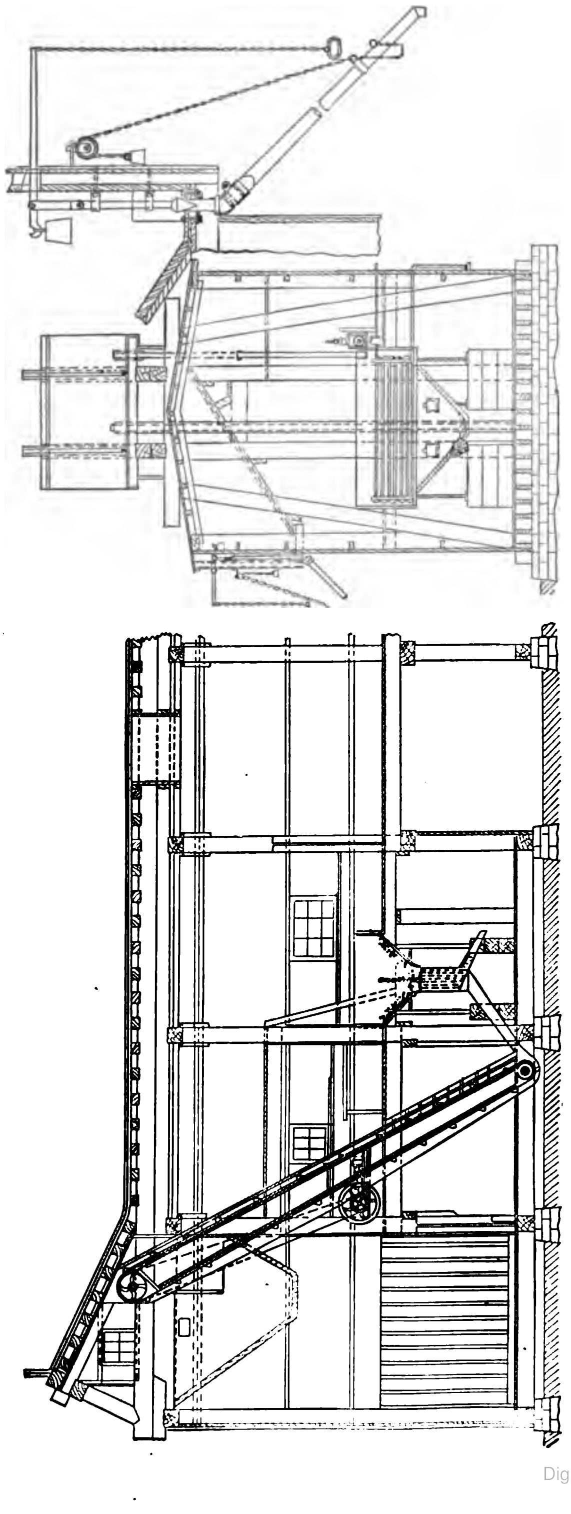

FIG. 208.—Sand plant at East Buffalo—Delaware, Lackawanna & Western.

on outside, in easy reach of engineman. Outlet spout 3-in. galvanized iron, telescope pattern, suspended by weight attachment at outer end.

The three 12-ft. bents at the end of the coal wharf at East Altoona are used for sand drying and storage. The drawings (Fig. 201), page 426, show the arrangement and some of the details of the apparatus used and with the general side view of the coal wharf (Fig. 200) convey a good general impression of the plant. Green sand is delivered in cars on the top of the wharf and dumped through trap doors into the two green sand bins which have a slope of 45 degrees. Below each green sand bin is a dryer with a capacity of 2000 lb. of sand per hour. The flow of green sand is regulated by a slide valve in the bottom of the hopper. Passing around the stove and surrounded by the green sand is a coil of 1.5-in. wrought-iron pipe which is connected to the chimney of the dryer. This pipe is perforated with 1.25-in. holes and serves as an outlet for the steam generated in the sand as it dries. The inside of the stove hopper is almost vertical and is made up of No. 12 wire netting, 3.5 meshes to the inch. The dry sand bins are near the top of the wharf and are emptied through a 4-in. galvanized iron spout with a flap cover which prevents rain from entering when the spout is raised. In the bottom of the dry sand bin is a heavy conical plug valve for shutting off the flow of the sand. This is raised by a cord which is tightened when the spout is lowered and falls into place by its own weight when the spout is raised. Any sand which may remain in the spout when it is raised, runs down into a funnel below the ball joint which connects to the dry sand elevator hopper.

The cost given for handling and drying sand, based on experience, does not as a rule mean much because usually men in attendance at such plants perform additional duties and the labor expense is not always equitably apportioned. Some approximate figures may, nevertheless, serve as a guide. One master mechanic reports the cost of unloading green sand from cars to storage bin by hand shoveling, at $1.25 per car. The only additional labor expense is the wage of one man working 12 hours per day at 12.5 cents per hour. The plant supplies about 70 engines every 24 hours. Adding in the cost of power necessary to elevate the sand, it is placed on engines at a cost of about 3 cents per engine. The average engine requires from 6 to 10 cu. ft. of sand each time it is supplied.

At another plant, of the ordinary storage type, the cost of labor is estimated at $1.25 per day, or when other items of expense are included, about 7 cents per engine.

At one engine-house loading with sand boxes by gravity, the capacity of dry sand hopper is given as two car loads (24 cu. yd.) and the time required to sand an engine as 2 minutes. The green sand storage bin has a capacity of seven car loads (84 cu. yd.); and the cost for handling and drying is said to be about 25 cents per cubic yard, or from 5 to 10 cents per engine.

CHAPTER XXX

THE ENGINE-HOUSE FOREMAN

The successful railroad man must be large in every way; big in thought, brain and conception—an organizer and an executive; and broadminded. He must be a keen analyst—able to separate the wheat from the chaff and to use the kernel in the heart of the nut. The engine-house foreman must know and study the details of all departments, specializing in his own; he must select the right men, quickly and unfailingly and must therefore be a thorough student of human nature.

A well-known operating officer remarked that any division of a railway will give a good account of itself if the positions of engine-house foremen and yardmasters are filled by the right kind of men. The writer suggests the inclusion of the chief train-dispatcher to make the complete operating trio. With harmonious relations and thorough co-operation between them, the real problems of train service will be satisfactorily met.

The engine-house foreman is responsible to the mechanical and transportation departments for the care of the locomotive from the time it is delivered to him after being released from an incoming train at a designated point (usually at the entrance to the engine-house yards) until it is returned to the designated point for outbound road movement. During this time he must know that his subordinates clear the ash-pan and clean the fire; inspect the boiler, tubes, fire-box and machinery; make the necessary repairs; supply coal, water and sand; inspect the front end to see that everything is in good working order and particularly that the front end diaphragm and netting is properly placed, adjusted and in condition to prevent throwing fire; turn the engine on a wye, or turntable and clean it. He must also keep in close touch with the chief train-dispatcher and yardmaster to know when trains are ready to move, so as to have power ready and engine crews on hand to man it. All of this may have to be done in less than two hours on each engine handled, although, in many instances it is attempted in a period of 20 minutes.

Unfortunately for the engine-house foreman it is almost invariably the case that the greater the need for the maximum number of engines in first class condition, the greater is the number of adverse conditions affecting his ability to fill the requisition. The heavier the business, the less time is available for caring for engines between trips, and usually, too, the greatest demand for power comes in periods of snow storms and cold weather when it is more difficult to keep locomotives in good condition, and when the problem is aggravated by engine crews falling out on account of sickness. In other words, the time that engine failures and train delays are most demoralizing to the service is just the time when it is hardest to prevent them.

It is necessary, therefore, that the engine-house foreman shall not only know how to make the best of a trying mechanical situation but he must also be somewhat of a diplomat. After hearing the engineman's story, which is usually far more intelligent than the brief and sometimes unreadable scrawl in the work-book, he must decide quickly and irrevocably whether the engine is about to fall to pieces or can stand another trip. He must be an all-round mechanic so as to determine which work to do and which to slight. This is especially desirable during time of traffic pressures, when the good, quick, unerring judgment of the engine-house foreman may save the day. He must also be sufficiently broad-minded to recognize there is a commercial side to be considered.

A capable foreman should be given ample assistance; there is no real economy in paying him the necessary salary and then requiring him to perform the duties of a telephone clerk or a call boy. With the increasing weight and size of locomotives with their many new and complicated appliances; and with the more exacting demands of traffic in faster freight and passenger train movement, more time is required in the turning and handling power and more conveniences and better facilities should be furnished. "A stitch in time saves nine" was always true, but it may be raised to "nineteen" when a failure to keep everything keyed up may mean sending out the wrecking train to take down rods or do other work which the engineman and fireman could care for without assistance on the type of smaller engines of former days.

The late William McIntosh, when Supt. M. P. of the Central of New Jesey suggested the following as an advertisement for an engine-house foreman:

> "He must be neither too old nor too young.
> Must have a good education and a thorough knowledge of handling and repairing locomotives.
> Must know how to handle men successfully.
> Must be diplomatic enough to keep on good terms with yardmasters, trainmasters, train-dispatchers and others.
> Must be of a cheerful disposition—an optimist preferred.
> Must not object to being on duty 52 Sundays and 300 nights each year.
> Must not be affected by climatic changes; must be willing to transact business out of doors in the absence of shelter.
> Must be like "Mark Tapley"—cheerful under adverse conditions.

Must answer the train-dispatcher pleasantly when he cannot furnish an engine that has not arrived.
Must explain how long it will take to put flues into the 99 and what's to do with the 001.
Must not murmur when obliged to pull one engine apart to repair another, while awaiting the convenience of the storekeeper and purchasing agent to bring out supplies.
Must always have a few engines up his sleeve to meet emergencies.
A regular job and *steady employment* awaits the successful applicant."

While there should be the closest working relations between the engine-house foreman and the yardmaster, there is nothing more important than a well-defined line of demarcation between their territories. There should be no common or neutral ground and preferably the engine-house foreman should take charge of the engine just after it leaves the yards or main tracks and before it reaches the ash tracks, or any of the other engine-house accompaniments. The point of delivery to the engine-house organization and the point of return from it to the yard organization, should be clearly defined. A trustworthy and impartial employee located there should keep an accurate record of every engine movement in and out, upon which all statements should be based. This arrangement, carefully planned and conscientiously executed, will go far toward maintaining harmony between two very important operating heads and avoid the "Kilkenny cat" affairs too frequently indulged in and which some operating officers have tacitly encouraged.

One of the most important roads was starting its fast passenger trains late from one of its terminals. The thermometer had dropped to 16 below zero. The superintendent visited the engine-house and found more ice than anything else. The engines were of the most powerful type but, under the conditions, could not move themselves out of the house under their own steam. Their trucks were literally frozen to the tracks. Other engines were brought in to start them. About 20 per cent. of the men were absent, principally because of sickness. It was colder inside the house than outside; the steam escaping up in the roof trusses came down as water and snow and the floor was covered with ice. Even after the engines were gotten out by almost superhuman efforts, they were in no condition to handle fast and heavy trains. The principal trouble was that the engines had outgrown the house and doors could not be closed behind their tenders.

To secure the best results the engine-house should be kept as clean as conditions will permit and by keeping the engines themselves clean it will be easier to inculcate neat habits in the enginemen, firemen and house employees. It requires constant vigilance on the part of the foreman and his men and of trainmasters and road foremen to break up the slovenly habits of enginemen and firemen who leave classification lamps or flags on engines after leaving their trains at terminals; who "forget" to take down marker and other lamps or flags and are almost as likely to have the headlights burning at high noon on a bright day as to light and keep them burning at night.

In a well-appointed and well-handled engine-house, the pits are kept clean and the scrap is removed and properly sorted. All parts of the engine are examined each trip and the necessary repairs made; air-brake equipment and other appliances tested and repaired; and records kept by the inspector of all work reported as necessary by the engineman and of all work done. Boilers must be washed out as often as the condition of water necessitates and as required by the instructions governing the road or division. Under the Federal regulations, this is done once a month, in the United States. These are a few states which have laws regarding washouts but it is to be hoped such state legislation will be discontinued as it is extremely confusing and serves no good purpose, merely adding to the burdens of the master mechanics and the engine-house foremen, in requiring a large number of duplicated reports. Fire-boxes and stay-bolts must be tested periodically; flues must be maintained in good condition and all movable parts of the engine kept in proper adjustment. Stay plates or frame binders must be kept in place and should fit properly; shoes and wedges should be carefully adjusted; rods must be rebushed or lined when necessary; valves and pistons must be kept tight and in good condition; driving boxes, trucks and tender journal boxes should be carefully looked over and packed, oiled and adjusted.

Engines are ordinarily left by the enginemen on the incoming track, from which they are taken by the hostler and his helper to the coal chute, stand-pipe, sand-house and ash pit before passing to the turntable and thence to the engine-house. Before leaving the engine the engineman inspects it and makes out a report of the work needed. He also reports the condition of the pop-valves, injectors, air pump and brakes. This report is deposited by him in a box to which only the foreman or his assistant have access. The report is used by the foreman as the basis for distributing the work among his help. The engineman then registers, in the book provided for that purpose, his name, his fireman's name, the engine number, the train number and the time of arrival. In some cases he also reports the time that he has been on duty and the amount of rest time that he must take according to the rules of the company.

After the engine is in the house an inspector looks it over and reports the condition of the various parts. His report and that of the engineman should coincide, particularly as to the machinery. A boiler-maker goes into the fire-box and makes the needed repairs. The front-end is opened up and examined every trip in some localities; not so often in others, but this inspection is regular. Boilers requiring it are washed out. In some places a record of engines for washout is made on a board. The hostler or dispatcher, by referring to this board, can place and prepare the engine so that this attention can be given without confusion.

When the engine is ready for service it usually has marks upon it, made by the various mechanics, showing that the fire-box, the front-end, the machinery, and all appliances, are all right. Often this marking is done on a board provided for that purpose, to which the call boy and the foreman refer when they are called upon by the train-dispatcher for engines.

One of the important duties for which the engine-house foreman is responsible, is the proper condition of the fire when the engine is delivered to the engine crew; and in these days of legislative agitation, inspection and supervision, it is essential to avoid unnecessary smoke. Mr. Geo. H. Baker, in an address before the New England Railroad Club, Boston, April 13, 1909, said:

> "Fuel saving and smoke preventing on railroads is mostly a matter of *agitation* and *education*. One of these is as necessary as the other, but the best results follow the proper employment of both means of improvement.
>
> Smoke from a standing locomotive is most objectionable when it is produced near a depot or an office building, and drifts to where it causes inconvenience or damage. It may be quickly suppressed at such times by opening the fire-box door and applying the blower slightly. Smoke from a running locomotive is most objectionable when it is produced in a dense volume, right after the throttle is closed. Then there are no exhausts to hurl it high in the air, and it trails back over the top and along the sides of the train. On passenger trains it enters the ventilators in the clearstory, or the open windows. On freight trains it obscures the vision of the trainmen. This should not be permitted. The smoke can be quickly dispersed by opening the fire-box door, and if necessary applying the blower for a few seconds. These movements on both standing and running locomotives result in the admission of a volume of fresh air above the surface of the fire, some of which engages in combustion with the gases liberated from the coal, burning some of these, and diluting the balance so they escape through the stack nearly transparent."

Handling of the engine crew-board, calling the men and manning the engines, has become a difficult and perplexing part of the engine-house foreman's duties. The constant changes in the working agreements with the enginemen and firemen tend to confuse; and as each change invariably further complicates and increases clerical work in connection therewith, this part of the foreman's work is not a bed of roses. He should be thoroughly conversant with the operating rules and the working agreements with the road- and shopmen, to prevent unnecessary controversies. The rosters of the enginemen and firemen showing their age in service and their seniority rating are usually made up once a year, in the office of the superintendent or master mechanic. The assignment of men to engines, unless "pooling" is in vogue, is also usually handled by the master mechanic and follows seniority lines.

"Pooling" engines—also termed "chain-gang" and "first-in-first-out"—consists of running all freight locomotives in turn, starting the first engine arriving on the first train departing, without reference to crews. By this method more engine mileage may be made in theory at least, because engines may continue in movement, while crews are obtaining rest. Whether the additional mileage obtained offsets the loss due to lack of care in maintaining the machine, which regular crews almost invariably give, is a question on which the ablest managers differ. Sometimes "pooling" applies to locomotives handling ordinary freight only, regular locomotives being kept on the more important fast freight trains. "Pooling" has been done on passenger trains, and in a few instances attempts have been made to put passenger engines and freight engines into the same pool. In such cases a compromise type of engine for both kinds of service is essential.

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